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ABSTRACT

Presented are critical reviews of 18 biology textbooks submitted for consideration by the Texas State Board of Education during 1984. These reviews are provided in three categories: (1) general biology textbooks: "Biology and Human Progress"--Prentice Hall; "Scott, Foresman Life Science"--Scott, Foresman; "Living Things"--Holt, Rinehart, and Winston; "Biology: An Everyday Experience"--Charles E. Merrill; "Biology For Living"--Silver Burdett; and "Biology: The Key Ideas"--Prentice-Hall; (2) academic biology textbooks: "Biological Science: An Ecological Approach"--Houghton, Mifflin; "MacMillan Biology"--MacMillan; "Addison-Wesley Biology"--Addison-Wesley; "Scott, Foresman Biology"--Scott, Foresman; "Heath Biology"--D.C. Heath; "Biology Living Systems"--Charles E. Merrill; "Modern Biology"--Holt, Rinehart, and Winston; "Prentice-Hall Biology"--Prentice-Hall; and "Experiences in Biology"--Laidlaw Brothers; and (3) advanced biology textbooks "Biological Science: Interactions of Experiments and Ideas"--Prentice-Hall; "Biology," 2nd Edition--Saunders; and "Biology," 5th Edition--Addison-Wesley. Each review includes general comments and references to specific page(s) in the textbook. Also included are 10 criteria to evaluate the treatment of science, a brief description of the methods and limits of science, analysis of creationist arguments and their scientific refutation, and testimony (by Bassett Maguire and Steven Schafersman) presented to the Texas textbook committee. (JN)

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A CONSUMER'S GUIDE TO BIOLOGY TEXTBOOKS 1985

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AND WILLIAM V. MAYER, Ph.D

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by Wayne A. Moyer, Ph.D.
and William V. Mayer, Ph.D.

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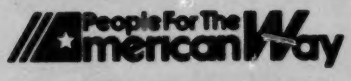

Table of Contents

Foreword 5

Preface 7

Introduction 9

General Biology 17

- Biology and Human Progress, Prentice-Hall 18
- Scott, Foresman Life Science, Scott, Foresman 21
- Living Things, Holt, Rinehart and Winston 23
- Biology: An Everyday Experience, Charles E. Merrill 26
- Biology For Living, Silver Burdett 29
- Biology: The Key Ideas, Prentice-Hall 31

Academic Biology 37

- Biological Science: An Ecological Approach, Houghton, Mifflin 38
- MacMillan Biology, MacMillan 43
- Addison-Wesley Biology, Addison-Wesley 48
- Scott, Foresman Biology, Scott, Foresman 53
- Heath Biology, D.C. Heath 60
- Biology Living Systems, Charles E. Merrill 68
- Modern Biology, Holt, Rinehart and Winston 73
- Prentice-Hall Biology, Prentice-Hall 79
- Experiences In Biology, Laidlaw Brothers 85

Advanced Biology 93

- Biological Science: Interactions of Experiments and Ideas, Prentice-Hall 94
- Biology, 2nd Edition, Saunders 95
- Biology, 5th Edition, Addison-Wesley 97

Testimony By Others 99

- Bassett Magure, Jr. 99
- Steven Schafersman 103

Creationism Refuted 107

- Modern Evolutionary Theory 108
- Gabler Evolutionary Theory 113

Bibliography 125

Foreword

Seventy five to 90 percent of class instruction is based on textbooks--reason enough for concern over the quality of textbooks that are used in the nation's classrooms.

Former U.S. Commissioner of Education Ernest Boyer wrote in High School: "Most textbooks present students with a highly simplified view of reality and practically no insight into the methods by which the information has been gathered and the facts distilled." Secretary of Education Terrel Bell has described the "dumbing down" of textbooks as a serious national problem. In a "Nation At Risk," the National Commission of Excellence in Education challenged textbook publishers to "upgrade and update textbooks to assure more rigorous content."

Although there is a consensus that textbook quality has declined over the past couple of decades, there is virtually no agreement about either why that decline has occurred or how it might be reversed.

Publishers claim that rigorous textbooks are not purchased and end up collecting dust in their warehouses. Textbook critics blame publishers for caving in to the demands of special interest groups by precensoring textbooks to avoid controversy. Teachers complain that administrators and school boards have usurped their professional decisions by mandating curricula and textbooks. And parents blame everyone for deteriorating textbook quality and abandonment of traditional standards of achievement.

Everyone has a strong opinion about textbooks but no one seems to be in charge of maintaining quality. In the end it seems that the system itself is at fault.

State school authorities frequently insist that textbooks be written "on grade level" as determined by readability formulas. This has encouraged publishers to use short words and choppy sentences. The result is textbooks that are actually harder to understand.

Curriculum guides--both statewide and local--require long lists of topics to be covered by textbooks. This forces publishers to "mention" as many items as possible leaving little room to develop any topic in depth. Science and social studies textbooks are particularly affected: several of the biology textbooks reviewed in this Guide are little better than book length vocabulary lessons.

State administrative rules governing textbook adoption--intended to guide textbook selection committees where statewide adoption is

practiced--have become vehicles for special interest groups attempting to control what children read. In Texas proponents of so-called "scientific creationism" have contributed to the decline of biology textbooks, as noted repeatedly in this Guide.

Ultimately, local school authorities decide which books are purchased, but even here the selection process discourages publishers from producing more rigorous textbooks. There are simply too many books for teachers to review and too little time in which to do it. The result: The very worst textbooks are dropped, but so are the innovative and challenging ones. Successful middle-of-the-road textbooks are then emulated by other publishers, resulting in a dozen or so books for each subject that are clones of the best selling book.

The challenge of improving the nation's textbooks would be impossible except for one fact: people at all levels will make wise textbooks decisions when they are properly informed. Providing information that will lead to wise textbook selection decisions is the purpose of this Guide. It will assist textbook purchasers to identify those biology textbooks which maintain the integrity of science and teach the explanatory theories of the field. It will encourage textbook producers to improve their products through constructive criticism. Finally, the Guide will assist state textbook officials to address the issue of how special interest groups have contributed to the decline of textbook quality.

Our goal in publishing this Guide is to help create a permanent market for sound textbooks that convey our cultural heritage to our children, and teach them the intellectual skills needed to continue building the American dream. This year we have focused on science and biology; next year we will focus on American history and in future years on other subject areas. PEOPLE FOR THE AMERICAN WAY is proud to make this contribution to the greening of American education and in the years to come will continue to work to protect the American dream for our children's as well as our nation's future.

Anthony T. Podesta
President, People For
the American Way

Preface

PEOPLE FOR THE AMERICAN WAY, through its work in Texas, has become acutely aware that biology textbooks vary widely in their treatment of scientific processes, especially as applied to evolutionary theory. Dr. Gerald Skoog of Texas Tech University estimates coverage of evolution-related topics has declined 20-80% in the past 10 years in some of the most popular textbooks. Project Synthesis, a science education study commissioned by the National Science Foundation, found that both teachers and textbooks have moved from teaching the process of science to teaching the "facts" of science. Yet several recent reports on secondary education have called for improved science and technology education. High School, prepared by the Carnegie Foundation for the Advancement of Teaching, notes: "The study of science introduces students to the processes of discovery--what we call the scientific method--and reveals how such procedures can be applied to many disciplines and to their lives."

The responsibility for improving science education falls on local public school districts. Recognizing that their immediate task is selecting high quality textbooks, we have developed a set of 10 criteria to evaluate the treatment of science in high school textbooks. Although originally prepared to assist the Texas Textbook Committee, we feel these criteria will also serve a wider audience. When applied to the 18 biology textbooks submitted for consideration in Texas, we found the coverage of scientific processes ranged from a high of "A" to a low of "D." This demonstrates good biology textbooks are available and at no greater cost than books which merely recite biology "facts" without teaching how they are discovered.

Our book focuses on critical reviews of the titles submitted in Texas in April 1984. It is important to note these 18 books do not include all titles currently available for high school use since several publishers declined to submit textbooks from their catalog for consideration in Texas. Nevertheless, the list is representative of current biology textbooks and our comments on their treatment of science should prove invaluable to teachers, supervisors, administrators and lay people interested in improving science education quality in their local districts. To balance our reviews, we have included the comments of two scientists from Texas, Dr. Bassett Maguire, a zoologist, and Dr. Steven Schafersman, a geologist.

We have also included a fairly extensive rebuttal to objections raised by creationists Mel and Norma Gabler and Neal Frey. This discussion presents the science involved simply but accurately for people whose formal biology education may have ended as a high school sophomore or college freshman. A short bibliography is provided for those wishing to delve more deeply into evolutionary theory.

Readers may wonder at our emphasis on Texas. Very simply, Texas is the nation's largest textbook purchaser, comprising an estimated 7% of the total textbook market. Add to that a highly centralized textbook adoption process which lets the State Board of Education negotiate specific changes with publishers, and one can understand why "as Texas goes, so goes the nation." Since publishers cannot afford to produce a special Texas edition, what Texas orders is what everyone gets. It is no accident that nine of the 18 submissions for the 1984 Texas adoption cycle carry a 1985 copyright date readied with this market in mind.

Our work is dedicated to the education community. In the short run, our pioneering effort will help textbook review committees purchase quality biology textbooks; in the long run it will encourage routine review of science textbooks upon publication.

Michael Hudson, Barbara Parker, Tom Collier, Becky Vannison-Baldwin contributed at all phases of development of the Guide. We are also grateful to teachers and biologists throughout the country who read the Guide in manuscript form and offered many valuable suggestions. These include Prof. Jack Carter of Colorado College, Prof. Bassett Maguire, Jr., of the University of Texas-Austin, Dr. Franklin Flint of Randolph-Macon Women's College, Dr. Stuart Hughes of Central High School, Philadelphia and several high school teachers from Texas who asked that their names not be included. It is to these dedicated teachers and hundreds of others like them who meet the creationist challenge everyday in their classrooms and communities that this Guide is dedicated.

Wayne A. Moyer, Ph.D.
Science Director
Freedom To Learn Project
PEOPLE FOR THE AMERICAN WAY

William V. Mayer, Ph.D.
Professor Emeritus, University of Colorado
President Emeritus, Biological Sciences Curriculum Study

Introduction

What is Science?

A scientific theory represents a grand synthesis of information about some aspect of the natural world. The term "theory," according to John A. Moore, biology professor at the University of California-Riverside, "applies to a body of knowledge and explanatory concepts that seek to increase our understanding of ('explain') a major phenomenon of nature." (1) Thus in physics we encounter the theory of gravitation; in chemistry, the theory of atomic structure; and in biology, cell theory and the theory of evolution. All these theories are well established in their broad outlines, although certain aspects may be disputed. For example, we have little understanding of what causes gravity and the subject is undergoing intense research.

What, then, is a fact in science? It is an observation of nature which can be repeated by anyone who wishes to make the effort. In science facts and data are synonymous. A fossil, for example, is a typical phenomenon of nature about which numerous repeatable observations may be made: its physical dimensions, the geological stratum in which it was found, its structural resemblance to other life forms, the age of lava intrusions in the stratum, and so forth. Millions of observations like these have accumulated over the past several hundred years. They provide one basis for the theory of evolution which explains the remarkable diversity of fossils, their distribution through geologic strata and their resemblance to modern life forms.

Science is thus a body of observation with an accompanying explanatory theory. But science is also a process, a method for adding to our accumulating knowledge about the universe and how it works. On the principles of the scientific method the--"hypothetico-deductive method"--Dr. Moore notes:

> Scientific knowledge begins with a question — not surprising since there cannot be answers unless there are questions. Some phenomenon of nature is observed, we become curious about it and wish more information. It is nearly impossible to obtain an answer to any important question in science unless we first make a guess about what the answer might be. This guess is our hypothesis. The guessing is not a random affair. The guess will be based on various observations, hunches and clues. This process, in which we combine the specific bits of information and logic to produce a more general statement (a hypothesis) is known as induction.

There is an absolute requirement for the hypothesis: it must be testable...

So we have our question and we have formulated one or more hypotheses that represent possible answers. We continue by saying, if the hypothesis is true, the following consequences must follow. These consequences are deductions. If the hypothesis is true, as we are assuming, the deductions must also be true. Then we set about testing the deductions by making observations or performing experiments. If the data from the observations or experiments show that the deductions are incorrect, then we must either abandon the hypothesis or modify it to conform to what we observed from the tests. If the deduction proves to be true, then we can say that the hypothesis may be true--at least it has not been falsified so far. The more deductions that are tested and found to be true, the more likely it is that the hypothesis is true. Should we be able to formulate and test critical and elegant deductions and they continue to be verified, we reach the stage when we can say that the hypothesis is true beyond reasonable doubt. The hypothesis then becomes a statement that is part of the conceptual framework of the field.

In summary, then, the idealized view of scientific methods and the method being proposed to teach science are:

1. Ask a question.
2. Develop an hypothesis by induction.
3. Make deductions from the hypothesis.
4. Test the deductions.
5. Use conclusions from the tests to validate or falsify the hypothesis.

This same view of science was summarized by Judge William Overton, who struck down as unconstitutional the Balanced Treatment for Creation Science Law in Arkansas. (2) He noted in his decision that science is:

- Guided by natural law.
- Explanatory by reference to natural law.
- Testable against the world we perceive through our five senses--the empirical world.
- Falsifiable since logical deductions or explanations can be tested through observation.

Selecting Quality Textbooks

Translating these sophisticated concepts into science textbooks written at levels suitable for students who will use them is a difficult task, one which requires a thorough knowledge of both science and its processes. Selecting suitable textbooks is almost as difficult. Nearly 30 years ago a group of scientists wrote some interesting observations on what qualities should be sought in a science textbook. (3) Their comments are just as valid today as they were in 1957. In their view, good science textbooks should exhibit these four characteristics:

- They should show the difference between fact and theory, between the solid core of verified observation and ongoing intellectual explanation.
- They should make it very clear the textbook content is a selection of presently known observation and explanatory theory.
- They should cite unsolved problems in science--what is unknown in addition to what is known.
- They should show the relationship of a given subject to both other fields of science and broad problems of humanity.

How, then, can we recognize textbooks which meet these objectives? We would like to propose the following set of guidelines--a "Consumer's Guide to Science Textbooks"--that textbook review committees can use to select quality science textbooks.

1. Basic concepts and principles of science are covered in a well-ordered synthesis; the book is more than a storehouse of facts.
2. The coverage of science is modern, accurate and linked to the cumulative store of relevant concepts from the past.
3. The point of view is forward looking, opening "vast vistas of unanswered questions."
4. New terms are properly defined, meaningful and used several times.
5. Development of concepts builds from simple to complex in a logical sequence.
6. Study questions, when provided, are intellectually challenging and trigger more than a simple regurgitaton of facts.
7. A scientific theory is treated as an explanation of a major phenomenon of nature encompassing a broad range of observations.
8. The conclusions of science are backed with evidence and not presented as mere opinions or beliefs.
9. Scientific methods are accurately described and used in presenting the work of scientists.
10. Scientific knowledge is neither eliminated nor muted in response to parochial pressure.

It is important to keep in mind that our criteria focus primarily on the nature of science rather than treatment of biological knowledge. We chose this strategy for three reasons:

(1) Biology is the last science course most students ever take and thus provides our last opportunity to impart scientific literacy, now considered a national goal.

(2) Textbooks which ignore the processes of science almost invariably become pedantic, fact-ridden tomes that even four-color illustrations cannot save.

(3) Publishers who clearly recognize the absolute requirement that scientific hypothesis (and theories) be testable have no trouble excluding explanations derived outside of science from their books.

We hope you agree with our premises and will find our reviews useful. They are presented in three chapters, one for each level of biology commonly taught in high school. A few introductory paragraphs summarize our findings and are followed by discussions of individual textbooks. Under General Comments we present an overview for each book, including relative emphasis on various topics currently taught in high school biology. It is important to note our percentages are based on total pages of text exclusive of preface, table of contents, appendices, glossary and index. Under Specific Comments we provide examples of each textbook's strengths and weaknesses and suggest improvements. Here again we have dwelled on two interrelated topics: the treatment of science and coverage of evolutionary theory. Our view is admittedly narrow, but we firmly believe texts which fail to adequately develop these topics cannot prepare students for the coming biotechnological age.

Watered Down Biology

The course titled, General Biology, or Introductory Biology as it is now called in Texas, presents a particularly difficult problem. On the one hand is concern for a special group of students, sympathetically described by Pat Watkins, coauthor of Biology for Living (4):

> Those of us who have spent years with these unique students have done so knowing well that we would never have the luxury of being certain our students would be with us for the full school year. Some will leave to follow seasonal crops with their families, some will become pregnant and will leave school, some will be responsible for the pregnancy of another and will leave to find jobs in order to respond to that responsibility. The Juvenile Justice System will move some students along and still others will simply quit because they and the system are not compatible. Facing these realities it became necessary to prioritize the material I could share with my students during the weeks or months I would have them. After years of watching students come and go, and adjusting priorities to needs, I became less willing to use classroom time dwelling on the origin of the student's body than with what would happen to that body--how it could be protected and what impact it might have on the lives and bodies of others. (4)

On the other hand, High School argues for a core of common learning: "The basic curriculum should be a study of those consequential ideas, experiences and traditions common to all of us by virtue of our membership in the human family at a particular moment in history." (5) The author suggests a two-year science sequence including biological and physical sciences.

Both concerns are legitimate, but it is our opinion that the textbooks offered for General Biology, with one possible exception, fail to teach the basic concepts of either science or biology and therefore fail to meet the needs of those special students attracted to this course. A watered-down biology, such as the Texas content guidelines describe and these books reflect, does not prepare students to participate in our technological society.

The real answer lies in developing a new approach to teaching the concepts and processes of science to students distracted from learning by other aspects of their lives. Meanwhile, we believe it would be preferable to use no textbook at all, rather than the patronizing "dumbed-down" versions currently being offered. At least then the teacher will be forced to think through what is important in biology and to employ nontextual ways of conveying these concepts to students.

The coverage of evolutionary theory in the 18 books we reviewed ranges from excellent to nonexistent. The poorest coverage is among the submissions for General Biology (Introductory Biology); three textbooks do not contain any mention of evolutionary theory or even the word "evolution." One book, however, (Prentice-Hall, Biology and Human Progress) contains an above average review of evolutionary theory.

The nine titles for Academic Biology (Biology I) which we reviewed all contain at least one chapter dealing with evolution, although the quality varied from excellent to poor. Overall, we detect a leveling out of the recent trend to dilute evolutionary theory coverage, although some publishers have a long way to go before their products approach the quality found in books published in the 1960s. The effects of the recently rescinded Texas anti-evolution rule live on in many of the submissions in the form of highly qualified statements about aspects of evolutionary theory, omission of important evidence and continued inclusion of the "Texas disclaimer" ("evolution is treated as a theory rather than as fact") in the two textbooks Merrill submitted. These statements should be removed if the books are adopted.

National Significance of the Texas Adoption Process

As the country's single largest textbook purchaser, Texas can influence the development of teaching materials that are used nationwide. Schools spent more than $65 million for textbooks in 1983. A survey released by the Association of American Publishers in 1981 reported:

> Textbook publishers can rarely afford to turn away potential sales in a major adoption state [such as Texas or California]. Nor can they, in most cases, afford the luxury of maintaining two separate editions. Thus an edition prepared for Texas or California...often becomes the sole edition available nationwide.

Publishers readily admit that textbook changes are made if needed to get their books on the Texas-approved list. Changes made to meet Texas demands often become changes in textbooks that are used throughout the country. In 1981, hoping to make the American Heritage Dictionary acceptable for Texas classrooms, Houghton Mifflin publishing representatives offered to delete "offensive words" from the latest edition. In 1980, to placate Texas critics, publishers deleted Shirley Jackson's classic 1949 short story, "The Lottery," from the national editions of four literature anthologies. A publishing official explained the books "wouldn't be bought in Texas" if they contained the story.

Tom Giblin, assistant superintendent of Colorado Springs' Widefield School District, told a national television audience during a MacNeil-Lehrer Report segment in November 1982 that "a decision in Texas really...does make a textbook. If there's an exclusion of a paragraph or sentence because of something that Texas asked the publishers to do, we suffer that exclusion also in Colorado."

William Wood of the Follet Publishing Company told the Dallas Times Herald in August 1982, "It would be very difficult to write off the Texas Market. If we couldn't sell a book [in Texas] without creationism in it, I imagine you'd see it in there." Michael Kenny of Bennett Publishing told the same newspaper he would be inclined to edit out a textbook paragraph "if I know it will stir up a hornet's nest."

Felix Laiche of Doubleday's textbook division, Laidlaw, said on the Public Broadcasting Service "Crisis to Crisis" series in 1982, "If they [the Texas Education Agency] back us up against a wall and say, 'You either take it out or you won't sell the book in Texas,' then we'll take it out."

It is clear from such statements that the Texas textbook selection process deserves to be well understood not only by citizens in Texas but throughout the rest of the country as well. The pressures influencing publishers to make textbook changes for Texas approval must be scrutinized to ensure the motivation behind those pressures is--first and foremost--a quest for educational quality.

Description of the Texas Adoption Procedure

Texas is one of 23 states in the United States with a statewide adoption system of selecting textbooks. This means local school districts can use state funds to purchase only those textbooks that have been adopted (i.e. approved) by the Texas Board of Education.

The 27-member Texas State Textbook Committee meets every summer to recommend what textbooks should--or shouldn't--be adopted for use in Texas's more than 1100 school districts. (Each committee member can appoint an advisory committee of up to six teachers from a specific subject area to help make recommendations.)

The Texas Textbook Proclamation, revised annually by the Texas State Board of Education, sets the official guidelines for textbook content as well as adoption procedures. Proclamation 60 governing biology textbook adoption contains no mention of "evolution" or Charles Darwin. It was adopted in early 1984 over the protests of Texas scientists.

Citizen participation in the Texas adoption process takes the form of written comments on textbooks under consideration by the State Textbook Committee. Oral testimony may also be presented at two points: to the State Textbook Committee during its July meeting and to the Texas State Board of Education at a hearing prior to the November adoption decision. As a result of People for the American Way (PFAW) pressure, citizens may now defend textbooks up for adoption in addition to offering traditional objections. PFAW was also successful in convincing the board to permit written citizen responses to objections protestors raised.

This present volume is drawn from PFAW's written commentary on biology textbooks considered in 1984 and written refutation of creationist testimony. We have also added the oral testimony to the State Textbook Committee of two Texas scientists who reviewed the same 18 biology texts.

The State Textbook Committee recommendations--no more than five books per subject area and no less than two--plus lists of specific changes deemed necessary to bring the books into compliance with the proclamation, are made to the Commissioner of Education who then makes recommendations to the State Board of Education. The State Board considers the commissioner's recommendations at its annual November meeting. Contracts are signed in mid-December provided the publishers agree to make the required changes. The textbooks then remain in use for at least six years; local school districts choose titles from the adoption list provided for each subject.

References

(1) Moore, John A. "Science As a Way of Knowing--Evolutionary Biology," American Zoology 24 (1984): 467-534.

(2) "Creationism in the Schools: The Arkansas Decision," American Biology Teacher 44 (1982): 172-197.

(3) Behnke, John A., et al. "Criteria for Preparation and Selection of Science Textbooks," AIBS Bulletin 1 (1957): 26-29.

(4) Response to Oral and Written Testimony at the Hearings Before the Commissioner of Education and the State Textbook Committee, (The Texas Education Agency, 1984), 2:400.

(5) Boyer, Ernest, High School. New York: Harper and Row, Publishers, 1983), 302-303.

(6) As Texas Goes, So Goes the Nation: A Report on Textbook Selection in Texas, (Washington, D.C.: People For The American Way, 1982), Chapt. 2.

General Biology

The six books in this category (Introductory Biology in Texas) are simplified selections from the content of biology. They treat students as below average in both reading level and ability to learn. The books largely fail to fairly represent either science or the discipline of biology. Five of the books do not even define the term "theory." Three do not mention "gene splicing"--the most promising technique of the last decade. Two do not contain any material on evolution and, in fact, do not even use the word "evolution."

Although none of the General Biology texts can be considered more than minimally acceptable, one stands out as totally unacceptable: Prentice-Hall's Biology: The Key Ideas contains so many factual errors resulting from hasty or inaccurate generalizations that it misleads students about the living world. It does not include "theory" as a part of the scientific process, uses an outdated systematic approach and emphasizes only human physiology.

We recommend that no texts be adopted in this category since they all offer a low-level, watered-down course which is a disservice to high school students. If it is necessary to recommend a book for adoption, then we can support only one book, Prentice-Hall's Biology and Human Progress.

18 BIOLOGY TEXTBOOKS

Title: Biology and Human Progress, 6th Edition (1985)
Author: Charles Tanzer
Publisher: Prentice-Hall, Inc., Englewood Cliffs, New Jersey 07632

General Comments

The 503 pages of text are divided into eight units, opening with a unit on classification (14%). The next four units (46%) deal with human physiology which includes metabolism, food and life, behavior, disease and reproduction. The remaining units deal with heredity (11%), "Life in Ages Past" (9%) and ecology (10%). The term "evolution" is used and the four sections of Unit 8 provide an extensive review of earth-life including human evolution and mechanisms of evolution. Despite heavy emphasis on human physiology, other organisms are discussed. We found this textbook to be acceptable.

Specific Comments

p. 16: Adaptation (entire section).

Adaptation of animals and plants to particular environments and ecological niches is one of the remarkable facts of life, and raises one of the most important questions in biology: "How can we explain the remarkable diversity of earth-life?" This section would be strengthened by concluding with such a question while noteing it would be raised again in Unit 8 (Life in Ages Past).

p. 19: 1. Find a problem and state it clearly and definitely.

This first statement of a scientific method would be made more accurate by substituting question for problem.

p. 19: #4. They test every hypothesis to see if it is a correct answer to the problem. Often this is done by performing experiments.

As written, this statement is inaccurate. Scientists first make a deduction from a hypothesis--a prediction--and then make observations to learn whether or not it works; a hypothesis may be correct. Better to say, "They test every hypothesis to see if it is an incorrect answer to the problem (question)."

p. 20: Controlled Experiments (entire section).

The experiment described--testing a substance for possible carcinogenicity--is too sophisticated for an introductory section. In addition, using whole animals in an LD_{50} test (lethal dose--50% die) has been questioned as a routine procedure. Substitute a simpler experiment, perhaps something from Koch's work.

pp. 14-25: Section 1-1. What Does Biology Teach You?

This section does not define theory, a serious omission. A theory is a grand synthesis of information--data--about some phenomenon in the natural world. Cell theory is an example.

p. 35: Three Kingdom Classification (entire section).

This system of classification is outdated and should be replaced with the five-kingdom system.

p. 34: An Early System of Classification (entire section).

The kingdom-to-species ranking is not adequately explained. What is a species? It should be defined and binomial nomenclature introduced. (The first name is genus name; the second is the specific epithet or name; together they constitute the species name.)

p. 296: Pork Worms (entire section).

p. 297: Hookworms (entire section).

These parasites should be identified as roundworms and related to Unit 1, Section 1.4: What Animals Exist in the World?.

p. 298: What Diseases Are Not Infectious? (entire section).

This section should at least mention inborn errors of metabolism which can be discussed further in Unit 7 (Heredity).

pp. 392-398: Section 7-5. How Can Heredity Be Improved in Plants and Animals?

Gene splicing and potentials of genetic engineering should be covered in this section. The concepts are not difficult to master and their inclusion will reinforce understanding of molecular biology.

p. 430: Some believe that many small changes took place over a long period of time....Others believe that greater changes could have happened in shorter time periods....Many scientists believe that both slow and rapid periods of change could have happened.

Scientist reach conclusions based on evidence. Stating such conclusions as beliefs is misleading and inaccurate.

p. 438: There are vestiges of organs in many animals.

p. 440: Discussion 14:4. What are vestiges?

Why not use "vestigial organs" instead of vestiges?

pp. 441-450: Section 8-4 What is the Story of Human History? (entire section).

This otherwise adequate discussion of human evolution has two problems. First, the term "human evolution" should replace "human history" which is inaccurate. Second, there should be a chart summarizing our present understanding of human evolutionary lineage. The one used in the "Ancestors" exhibit at the American Museum of Natural History is excellent.

pp. 504 - 523: Glossary.

Eucaryote is not defined.

Evolution: The process of change in living things resulting in the development of new types."

This definition is inadequate; substitute species for "type" and add: descent with modification.

Procaryote is not defined.

Theory is not defined.

Title: Scott, Foresman Life Science (1983)
Authors: LeVon Balzer, Phyllis L. Goodson, Irwin L. Slesnick, Lois Lauer, Ann Collins and Gretchen M. Alexander
Publisher: Scott Foresman and Company, Glenview, Illinois 60025

General Comments

The 480 pages of text are divided into six units and 24 chapters. Some 32% of the book is devoted to classification and describing of plants and animals using the five-kingdom system. An additional 28% of the book covers human physiology including reproduction; 15% discusses ecology. There are also single chapters on genetics and "Change Over The Years" (15 pages or 3% devoted to the latter). The word "evolution" is not used in this book although "natural selection" is. This is a traditional biology textbook consisting of descriptions of plants, animals and human physiology. It contains little discussion of recent biological developments.

Specific Comments

pp. 10-11: The Scientific Method Is a Way of Knowing (entire section).

Contrary to the text, there is no one scientific method; it varies depending on circumstances. However, there are certain common characteristics to the way scientists work. First, they emphasize questions, not problems. Second, hypotheses lead to deductions which can be tested by observation.

p. 11: ...A theory is an explanation supported by data, that makes the most sense of a problem.

This is an inadequate definition of a theory which represents a grand synthesis of information about some aspect of the natural world.

p. 67: Did you know? Classifying Human Fossils: The Piltdown Puzzle (entire section).

Using this story to illustrate the self-correcting nature of science is sound but only if there is accompanying discussion of accepted and verified fossil evidence of human ancestors. Either add human evolution or remove this section. Otherwise, students are led to understand there is no reliable evidence for human evolution.

p. 70: ...He gave each plant species a scientific name. The scientific name was made of two words. The first word named the genus of the plant. The second word gave the species name.

This is in error. The second word gives the specific epithet or name. The species name is the combination of both words, hence binomial nomenclature.

P. 285: Phagocyte eating a pathogen (illustration).

This and other photomicrographs should have some indication of scale, perhaps a line representing the diameter of a red blood cell.

p. 372: 20-1 Inheritance of Traits.

There is nothing on gene splicing in this chapter despite its economic and political importance. The concepts involved are not that difficult.

> p. 395: However, the bones of many dinosaurs have been found in ancient rocks.

These fossils are not bones but mineral casts of the long-gone original bones. Casual treatment of this important observation leaves the student open to uncritical acceptance of claims that humans and dinosaurs coexisted.

> p. 394: Therefore, fossils found in deep layers of rock and soil are often thought to be older than fossils found in layers closer to the earth's surface....Most scientists think that, if the rock layers have not been disturbed, the fossils in E would be older than those in B.

Scientists reach conclusions based on evidence. Use of informal terms like "think" and "believe" distorts the nature of science and makes it seem as though scientists merely have opinions. This evidential nature of science must be repeatedly reinforced in introductory textbooks.

p. 397: Breakthrough. The Neandertals: The Super-Hunters.

The illustration is pure fantasy and has little to do with biology unless the publisher chooses to enlarge the discussions of human evolutionary lineage, of which Neanderthals were but one step. The variant spelling of "Neandertals" should also be explained.

pp. 482-489: Glossary.

Experiment is not defined.

Evolution is not defined.

Theory: explanation that best explains a problem.

This definition fails to convey the power of a theory, such as cell and evolutionary theory, to explain a large body of observations.

Title: Living Things: An Introduction To Biology (1985)
Authors: Harold Teter, Gabrielle I. Edwards, Frederick L. Fitzpatrick and Thomas D. Bain
Publisher: Holt, Rinehart and Winston, Publishers, CBS Inc., 383 Madison Ave., New York, New York 10017

General Comments

The 472 pages of text are subdivided into seven units containing 44 chapters. Beginning with cells and basic chemistry (11%), the book moves through reproduction in plants and animals (12%) and ecology (13%). Classification and description of plants and animals (33%) is based upon the three-kingdom system. Human physiology is covered in the final unit (30%). This highly traditional book consists of taxonomic descriptions plus physiology with little discussion of recent developments in biology. "Evolution" does not appear in either the index or glossary although there is a limited discussion of evolutionary concepts under the rubrics of human history and adaptations.

Specific Comments

pp. 5-6: What is Science? The Scientific Method (entire section).

This discussion of a scientific methods omits three essential points. First, a deduction is made from a hypothesis which is then tested by observations. Second, theory is not defined: a scientific theory represents a grand synthesis of information about some aspect of the natural world. Third, a hypothesis must have the absolute quality of being testable.

p. 86: Chapter 10--Heredity.

This chapter--the only one on heredity--contains no discussion of genetic disorders. Considering the importance of this topic to the lives of students we feel this is a serious omission.

p. 99: Chapter 11--Mutation and Adaptation (entire chapter).

This chapter contains nothing on evolution, the end product of natural selection. This is a most serious omission which deprives students of a solid knowledge of modern biology. Adaptation is not evolution. We feel it is inconceivable that a modern biology textbook--for any level--should omit an extensive discussion of evolution.

p. 100: When a gene mutates, the new form may be an improvement, but in most cases it is not. Some mutations are so harmful that they cause early death.

A mutation was previously defined as a change in a DNA molecule (page 99). Using this definition, most mutations are neutral, neither harming nor benefiting the organism. This sentence thus gives the student an erroneous impression. Also, most harmful mutations are recessive and expressed only in the homozygous state.

p. 107: The Changing World of Life (entire section--2 pages of text).

The muted discussion of evolution and its fossil evidence in this section is a travesty of one of the most important theories in biology.

p. 175: The first word in the double name tells to which group of similar species this particular kind of living thing belongs. Such a group is called the genus...the second word is the name of one particular species in the genus.

This is incorrect. The second name is properly called the specific epithet or name. The species name is both words taken together, hence binomial nomenclature.

p. 178: Problems in Classification.

The four-kingdom approach to classification used in this book is out of date and should be corrected to include monera and fungi as separate kingdoms.

p. 334: These methods help scientists form theories. A theory is not an absolute fact.

Certainly a theory is not a fact, either absolute or otherwise, but the publisher does not discuss theory at all except for this negative comment. Its inclusion here reflects the obsolete wording of the old Texas anti-evolution rule and should be deleted. In its place the publisher should provide an accurate description of a theory. (See the comment about page 5.)

p. 334: Many scientists believe the theory that humans developed from earlier forms of life.

Some scientists think that two major changes took place during the development of humans.

Using such terms as "many scientists believe" and "some scientists think" is inaccurate and misleading. Scientists reach conclusions based on evidence as described on pages 5-6. These passages and others like them should be edited to agree with accepted practice.

pp. 481-490: Glossary.

Evolution is not defined.

Natural selection: process expressed by Charles Darwin that says organisms that best suited their environment tend to survive.

Lamarck expressed this same idea; Darwin added the notion that only inherited variations were important.

Species: a distinct kind of living thing.

This is incorrect. A species is a population of naturally interbeeding plants or animals.

Theory is not defined.

26 BIOLOGY TEXTBOOKS

Title: Biology: An Everyday Experience, 2nd Edition (1985)
Authors: Albert Kaskel, Paul J. Hummer, Jr. and Lucielle Daniel
Publisher: Charles E. Merrill Publishing Co., A Bell & Howell Company, Columbus, Ohio 43216

General Comments

This book contains 578 pages of text, divided into seven units and 31 chapters. The first unit covers cells and classification of animals, plants, monerans, protists and fungi (22%). Human physiology is covered in two units (33%). Reproduction (12%), genetics including 10 pages on evolution (11%), and ecology (12%) are covered in succeeding units. The term "evolution" is used in this book although "human evolution" is not, in any guise. The textbook's major emphasis is on human physiology.

Specific Comments

p. iii: Scientific theories are treated as always subject to revision in light of new evidence. For example, evolution is treated as theory rather than as fact.

The second sentence is a non sequitor and reflects an inaccurate definition of a theory. Theories are based on facts; they are explanations of facts and cannot themselves be facts in the scientific sense. The sentence should be deleted.

pp. 14-16: 1:7 What is the Problem? (entire section).

This discussion of a scientific method (there are several) is incomplete. First, scientists ask questions of nature; solving problems is secondary if it is considered at all. Second, a hypothesis leads to a deduction which can be tested by observation or experiment. If it can't be tested, the hypothesis is not scientific. Third, theory is not defined. A scientific theory represents a grand synthesis of information about some aspect of the natural world. It is not an unproved notion.

pp. 46-47: 3:7 Classification Shows Closeness.

This is one of the few biology textbooks to point out that modern classification systems suggest organisms are related. The publisher should ask the critical question, "Why are organisms related as taxonomy strongly suggests?" This could serve to introduce the hypothesis of evolution.

p. 48: Its name comes from the genus Felis and species domesticus. A scientific name is both the genus and species of the living thing.

This is an incorrect definition. The second name is correctly called the specific epithet or name. The species name is both words taken together, hence binomial nomenclature.

p. 51: 3:10 A Five-Kingdom System Instead of Two (chart and illustration).

This chart is oversimplified and inaccurate: some monerans move while some animals are sessile. The basis for the five kingdoms is complexity and mode of nutrition. Listing "producer, consumer or both" does not include the latter concept. Fungi, for example, are absorptive while animals are ingestive.

p. 491: 26.11 Switching Genes (entire section).

An effort has been made to include modern biological techniques but more should be done with genetic engineering considering its potential importance in the lives of students.

pp. 595-506: Chapter 27--The Changing World of Life (entire chapter).

Evolutionary theory is too complex and important to be dismissed in three pages (500, 501 and 504). Adaptation is not the same as evolution. The discussion of natural selection is inadequate. The definition of evolution, "the changes that occur in living things over time," fails to include the notion of descent with modification and development of species. A biology textbook which fails to discuss evolutionary theory is no better than a chemistry text which omits atomic theory.

p. 504: Evidence for a theory of evolution comes from mutations and fossils. (blue side note).

This statement confuses evidence for evolution, provided in part by fossils but also from many other sources, with mechanisms of evolution. Mutations are a source of variations in the modern synthetic theory of evolution which help explain how evolution occurs; they are not evidence for evolution.

p. 580: Appendix B: Classification Outline, etc...

This simplified chart of the five kingdoms is in error. Monerans lack a nuclear membrane; they contain nuclear material. Eucaryotes have a nuclear membrane and organized nucleus. This distinction is important.

p. 580: Fungi kingdom.

p. 581: Fungus kingdom.

Why the difference? This error should be corrected

pp. 584-593: Glossary.

Evolution changes that occur in living things over time.

This definition is inaccurate. Evolution works on populations not individuals.

Natural selection is not defined.

Theory is not defined.

Species: smallest division of living things.

This definition is inaccurate since there are taxonomic divisions below species.

Title: Biology For Living (1985)
Authors: Patricia M. Watkins, Dorothy Chang-Van-Horn and Howard E. Kron, Jr.
Publisher: Silver Burdett Company, Morristown, New Jersey 07961

General Comments

The 573 pages of text are divided into seven units and 30 chapters. Unit 1 (12%) covers food, nutrition and consumership while introducing simple chemistry. Units 2 and 3 (31%) treat classification of plants and animals using the two-kingdom system. Human physiology, reproduction and development and disease compirse the remaining four units (51%). Evolution and natural selection are not covered at all. The heavy emphasis on human physiology makes this textbook little more than a poor human biology book. There is limited career information.

Specific Comments

p. 3: Chapter 1--Food and Nutrition (entire chapter).

One would expect to find a chapter like this in an elementary health textbook, not a tenth grade biology textbook. How was all this information obtained? How are all these nutrients used by living organisms? This is not the science of biology but a listing of nutrients, vitamins and minerals. Every opportunity to develop biological principles has been ignored.

pp. 23-66: Chapter 2--What We Buy, Chapter 3--Why we Buy; Chapter 4--Selling the Product (entire chapters).

None of the material covered in these chapters is biology. This unit fails to provide the content generally required in an introductory biology curriculum.

p. 75: Only members of the same species may reproduce with one another.

This is wrong. Lions and tigers produce viable and fertile offspring in zoos although not in nature. Donkeys and horses produce mules which are viable although usually sterile. Restate as: "A species is a population of naturally interbreeding plants or animals."

p. 88: The small growths from these yeast cells are buds... (illustration from chapter on plant reproduction).

The illustration is indistinct and contains no scale to indicate yeast size. In addition, yeast cells have not been discussed and fungi are not plants. Why introduce them as an example of budding in plants? Students lack the experience necessary to understand yeast reproduction at this point in the course.

p. 182: Sexual reproduction involves the union of a sperm cell (top) with an egg cell (bottom) (illustration).

The illustrations are poor and reproduced at two different magnifications which confuse the student. Include a bar to indicate relative sizes.

p. 183: Internal Fertilization and Development (entire section).

How can students possibly understand the complexity of ovulation and fertilization without diagrams? At least diagrams of cat reproductive systems should have been included.

p. 194: Since it (a tadpole) is taking in food, it needs a digestive system. A long intestine, similar to that of a fish, develops.

Why is the intestine long? Why does it shorten dramatically during metamorphosis? (The animal starts by eating algae and plants which require a long digestive path and ends as a carnivore--an insect eater--which requires only a short intestine.) An opportunity to discuss an important biological concept is missed. The first sentence introduces a causality that does not exist by stating, "...it needs a digestive system."

p. 382: Figure 21.1. A human sperm cell (top) and a human egg cell (bottom) (illustration).

The egg and sperm diagrams should be drawn to the same scale or the scale of each included and noted.

pp. 603-620: Glossary.

Evolution is not defined.

Hypothesis is not defined.

Natural selection is not defined.

Theory is not defined.

pp. 621-630: Index.

The following important biological topics were omitted from this textbook: population, environment, ecology, gene splicing, energy use and metabolism and scientific methods.

Title: Biology: The Key Ideas (1983)
Authors: Harry K. Wong and Malvin S. Dolmatz
Publisher: Prentice-Hall, Inc., Englewood Cliffs, New Jersey 07632

General Comments

This large format textbook contains 312 pages divided into five units and 44 chapters. The first unit extensively covers the scientific method (14%). Unit 2 covers classification, cells and the three kingdoms of living things in that order (27%). Human physiology (22%) and reproduction and heredity from the human perspective (18%) are covered in the next two units. The final unit is devoted to photosynthesis, respiration and ecology (17%). Natural selection and origin of species are presented in a single chapter which does not cover evidence for evolution. The textbook emphasizes human physiology with other organisms tending to be viewed only as they relate to humans.

Specific Comments

p. 12: Science is an orderly way of thinking used to solve problems.

This is inaccurate. Better to say, science is an orderly way of answering questions. Observation is important but only if it is directed by hypothesis. This and further sections overemphasize problems and neglect inquiry.

p. 21: 3B The Hypothesis Gives Direction (entire section).

The essential step of making a deduction from the hypothesis--a prediction--is omitted. Also omitted is the notion that hypotheses can only be disproved, one by one, until one alone stands as tentatively verified.

p. 61: In the two-word method, the first word is the genus and the second word is the species.

This is incorrect. The first word is genus, but the second word is the specific epithet or name. Together they create the species name, hence the term binomial nomenclature.

p. 62: Species sapiens. Few body hairs; high forehead; large chin.

Sapiens is not a species; Homo sapiens is. Humans have as many body hairs as primates; they are just lighter and thinner.

p. 67: The Range in Size of Living Things (illustration).

The singular of bacteria is bacterium.

p. 75: Plant and animal cells are not alike.

This is incorrect. Plant and animal cells are more alike than different. This is the basis of cell theory as stated by Schleiden and Schwann.

p. 76: Cell Wall. Only plant cells have a cell wall outside of the cell membrane.

This is incorrect. Cells of fungi, bacteria and so forth all have cell walls, not just plant cells.

p. 76: Endoplasmic Reticulum...It is believed that the endoplasmic reticulum provides a place on which chemical activities can take place.

Why use "believe" when evidence demonstrates these activities?

p. 76: The Cell: Some parts and their Functions (illustration and accompanying text).

Both singular and plural forms of cell organelles are used in this illustration; use one or the other.

p. 77: Chromosomes/Chromatin.

These terms are not synonymous.

p. 80: The cell is the basic unit of structure of an orgarism.

The cell theory states that cells and cell products make up an organism.

p. 85: By the process of osmosis and diffusion, cells exchange materials and water with their environment.

Water and materials diffuse out of the cell by osmosis (illustration).

Materials do not move across a cell membrane by osmosis, only water does. Osmosis and diffusion are not synonymous.

p. 87: The Three Kingdoms (illustration).

The three-kingdom system is illustrated even though the textbook is supposed to be using the five-kingdom system.

p. 96: The Plant Kingdom is Divided into Two Phyla (illustration).

Botanists use the term "divisions" not "phyla".

p. 117: Vertebrates have one or two pairs of appendages.

Some vertebrates such as snakes have no appendages.

p. 118: The Characteristics of Fishes--skeleton of bones covered with scales.

Sharks have skeletons of cartilage. The skeleton is not covered with scales, the skin is. Some fish don't have scales.

p. 119: The Characteristics of Amphibians--lungs in the adult stage.

Some amphibia do not have lungs, such as the mud puppy.

p. 121: The Characteristics of Birds -- external development of eggs.

This characteristic is not diagnostic of birds. Reptiles, amphibia and fish all have externally developing eggs.

p. 122: The Characteristics of Mammals--covered by hair or fur.

Not all mammals (whales, elephants) are covered by hair or fur.

p. 126: The most complex and successful form of animals belong to the phylum chordata.

Then why are there more species and more total living mass of insects than all other phyla combined? What is meant by "complex" and "successful"?

p. 126: Vertebrates have a backbone, endoskeleton, complex nervous and circulatory systems, outer covering and one or two pairs of appendages.

All organisms have an "outer covering" and not all vertebrates have paired appendages.

p. 126: Amphibians have gills in their tadpole stage and lungs in their adult stage.

Not all amphibia have lungs.

p. 126: Mammals bear their young alive...

Some mammals (monotremes) lay eggs.

p. 127: Evolution is thought to be the cause of the diversity of life. Evolution means change.

This is a totally inadequate definition of biological evolution which should include the concept of descent with modification.

p. 129: How Living Things Change--the young struggle to live.

The so-called "struggle" is really competition for food, mates and space, and occurs at all stages of an organism's life cycle, not just when it is young.

p. 130: 6. Accumulations of Traits. After many generations, the variations tend to accumulate and collect. When the variations appear together in succeeding generations the result may be a new species...

These two sentences make no sense from a scientific point of view.

p. 131: Many scientists think the result of evolution is the diversity of life (repeated under Key Facts and Concepts).

Based upon accumulated evidence, scientists conclude that modern organisms have descended with modification from earlier ancestors.

p. 131: Evolution is the idea that living things gradually change over time.

The definition is scientifically inaccurate. Species or populations change over time, not "living things" which implies individuals change over time.

p. 136: The Human Skeleton (illustration).

Humans do not have "front" and "back appendages."

p. 140: A person cannot decide to move smooth muscles. They cannot be controlled.

Smooth muscle is certainly "controlled" and in some cases voluntarily.

p. 162: 30. Name four functions of plasma.

The text does not provide them. Page 161 lists only transportation as a function of plasma.

p. 163: The veins carry blood without oxygen to the heart.

There is still oxygen in blood flowing in veins.

p. 163: The circulatory system must operate at homeostasis at all times.

How does circulation operate "at homeostasis"? The term is misused.

p. 171: A hormone excites, or turns on, a body activity.

A hormone can also turn off a body activity.

p. 197: An inherited disease is caused by the inheritance of an incorrect message.

The preferred term is not inherited "disease" but rather "disorder."

p. 224: Why Cells Need to Divide.

Cells do not "need" to divide; use of such terms is anthropomorphic.

pp. 204-259: Unit 4 Reproduction and Heredity.

The genetics materials are classical and outdated. Gene splicing, genetic disorders and so forth are not included although these topics appear in the news daily.

pp. 313-316: Glossary.

Geometric growth: any thing that grows by developing itself.
This definition is inaccurate.

Parasite: an organism that lives at the expense of another.
This definition is too inclusive and therefore inaccurate.

Theory: a hypothesis that has data to support it.
This definition is inaccurate.

Natural selection is not defined.

Eucaryote is not defined.

Procaryote is not defined.

Embryo: the developing egg.
This definition is not accurate.

These are but a fraction of the errors and misstatements to be found in this textbook.

Academic Biology

Nine titles were submitted to the Texas Textbook Committee for consideration under the subject heading "Biology I." This is the same course other systems term Academic Biology and College Prep Biology. It is the standard American first level biology program which emerged at the turn of the century and became fixed as presently taught in the 1920s when Modern Biology was first published.

Six of the nine textbooks follow what might be called a taxonomic approach to biology. That is, more than a third of the content is devoted to reviewing earth-life by kingdoms, phyla and classes. There is also a heavy emphasis on human physiology with supporting sections on cell biology, genetics and ecology. These six books and their publishers are: Macmillan, Macmillan Biology; Scott, Foresman, Scott, Foresman Biology; D.C. Heath, Heath Biology; Holt, Rinehart & Winston, Modern Biology; Prentice-Hall, Prentice-Hall Biology; and Laidlaw Brothers, Experiences In Biology.

Of the remaining three books, two employ a functional approach. Biological functions including reproduction, nutrition, development, internal transportation and control are developed using examples from various taxonomic levels. The Charles E. Merrill book, Biology: Living Systems, separates simple organisms, plants and animals into units and thus remains closer to early biology textbooks which contained botany, zoology and human physiology. The Addison-Wesley book, Addison-Wesley Biology, uses representative organisms regardless of kingdom to illustrate each function, and is thus is more firmly committed to the functional approach.

The final textbook on this subject takes a unique thematic approach. The full range of biological knowledge is introduced within an ecological context. Published by Houghton, Mifflin, Biological Science: An Ecological Approach was developed in the 1960s by the Biological Science Curriculum Study and is now in its fifth edition. It represents one of three thematic approaches, the others being molecular biology and genetics; these were not submitted for adoption in Texas by their commercial publishers.

38 BIOLOGY TEXTBOOKS

Title: Biological Science: An Ecological Approach (1982)
Author: Biological Sciences Curriculum Study
Publisher: Houghton, Mifflin Company, One Beacon Street, Boston, Massachusetts 92918

General Comments

This book contains 728 pages of text divided into six units and 20 chapters. True to its name, the book starts off with an extensive discussion of ecological principles (14%). Classification of living things is covered in the next unit (13%) which leads to interactions of organisms within particular environments and through time in Unit 3 (22%). Unit 4 (24%) considers cellular structure and physiology and behavior of individual organisms. "Continuity of the Biosphere," Unit 5 (17%), includes reproduction, heredity and evolution. The book concludes with a unit on human ecology (9%). This textbook is organized to take the student from familiar organisms toward populations and external organization and then back to cells and internal organization. The emphasis is on specific processes as applied to biology.

This text differs from all the others in having a theme (ecology) running throughout the book. It presents biological content in relation to the environment and is an alternative to the approach of the other texts submitted for Biology I. Science is treated as a process, earning high scores on our report card.

Although some students have complained this text is difficult, the authors intended to produce a book that challenged students to think. Their success is evident in the end-of-chapter questions that go far beyond the usual requests to "list," "identify" and "describe." This creates a degree of uncertainty among students who succeed best by memorizing and regurgitating "facts." Undoubtedly, the book's challenging nature is a major factor in their complaint.

Nevertheless, the textbook has proved popular among better-trained teachers who are frequently assigned above average students. There are several districts in Texas, for example, which purchased the textbook with local money in order to provide students with a rigorous biology course.

This is not to say the textbook has no problems. For one thing, it has 800 pages, making it one of the largest textbooks submitted for Biology I. Laboratory exercises are built into the text thus adding length but this is also the case for several other submissions. It could be asked whether the purposes of any introductory course are served by a book of such length.

The student edition also uses an outdated three-kingdom classification system, although the teachers edition does discuss four- and five-kingdom systems. The five kingdom system is logical, in line with recent evidence and preferred.

Finally the discussion of human evolutionary lineages reports most major fossil finds except "Lucy," yet fails to provide a hypothetical framework relating them. The recent "Ancestors" exhibit at the American Museum of Natural History demonstrates how much can be done with present evidence. This section needs revision.

Specific Comments

p. 11: A good hypothesis is simple and clear. It often suggests how to collect evidence that would either support or disprove the hypothesis. A hypothesis must be stated to make an investigation possible. Otherwise it may become another one of the interesting ideas with which science cannot deal.

We strongly support this concept of a hypothesis. If an idea can't be tested it is beyond the realm of science, quite apart from whether or not it is true. Creationism falls squarely within this category.

p. 11: "The ideal situation if (sic) for a hypothesis to he directly testable by experiment."

This typographical error needs to be corrected. We agree with the concept but suggest it be expanded to include alternative hypotheses. This discussion should also point out the kind of evidence (prediction) which would falsify a given hypothesis. In the long run, eliminating a wrong hypothesis is more important than supporting a possibly correct hypothesis.

p. 12: Theories in biology are great organizers of knowledge. They are much more than just hypotheses. They are supported by the best available evidence and even predict future events. Yet they contain allowances for modification, if necessary, with new discoveries. No reputable biologist would ever present the world with a theory that could not be modified.

This statement should be required reading for every school official who has ever said, "Evolution is just another theory which has not yet been proved."

p. 43: "2--3 Yeast. Note the small buds still attached to two yeast cells. These buds will separate from the parent cell and become new individuals (x600)."

We commend the publisher for including a scale of magnification with this and following photomicrographs. We urge they also include a scale with photomacrographs as with the illustration of coral in figure 2-1.

p. 145: Linnaeus' binomial system is simple. He used only two words to name each species. The first word indicates a group of similar species...The second word indicates a group of similar individuals. It is the species name, and is usually an adjective describing the genus....Neither the word indicating the genus nor the word for the species is, by itself, the name. The name consists of both words.

This confusing although essentially correct discussion of binomial nomenclature would be infinitely clearer if the publisher would substitute "specific name" or "specific epithet" for "the second word." See Wester's New Collegiate Dictionary.

p. 174: More than a century ago Ernst Haeckel proposed a third kingdom, Protista....Two more kingdoms have since been proposed--one to help resolve difficulties in classifying protists and one to remove mushrooms and their relatives from the plant kingdom.

Despite this opening discussion, the publisher insists on using the outmoded three-kingdom approach rather than the more logical and justifiable five-kingdom system. This is a serious fault and ill prepares students for further work in biology.

pp. 317-354: Chapter 10:--Life in the Past (entire chapter).

This extensive chapter on the history of earth-life as revealed by fossils is the most thorough discussion of the subject in any of the books we reviewed for Academic Biology. The nature and limitations of the geological record are reviewed, including a good discussion of radioactive isotope dating methods based upon long-lived isotopes. The heterotroph hypothesis is discussed briefly and its speculative nature stressed, although there are enough data accumulating in this area to warrant a more extensive treatment. True to the textbook's theme of ecology, fossil assemblages are discussed. The basic concepts of paleontology are presented, including similarity between fossil forms and modern organisms, evidence for extensive or mass extinctions plus evidence of a changing earth. Adaptive radiation and adaptive convergence are introduced as concepts emerging from close study of the fossil record rather than as evidence for evolutionary relationships.

p. 339: 10-27 Excavating bones at Dinosaur National Monument on the Colorado-Utah border (illustration).

Identifying the fossilized bones of dinosaurs as merely bones leaves the student with the erroneous impression that these fossils always contain original material rather than mineral deposits.

pp. 623-658: Chapter 18:--Evolution (entire chapter).

The publisher has chosen to separate the history of earth-life from its explanatory theory, the "theory of organic evolution." Certainly fossils and the geological record provide strong evidence for evolution, but the publisher should not ignore equally good evidence to be found in living organisms. Comparative anatomical, DNA and protein studies are not mentioned. We also question confining the discussion of evolutionary theory to essentially one chapter which may be easily omitted in the rush to complete a long course.

In this chapter on evolutionary mechanisms the concepts are developed from an ecological base paralleling the reasoning of Darwin, a superb naturalist. The discussion of speciation is closely linked to the definition of species which is shown to be inexact, reflecting the gradual separation of populations into distinct species.

p. 628: 18-6 Comparative embryology of some vertebrates. Zygotes are shown on the left, adults on the right and comparable embryological states between. (Drawings are not on the same scale.) The similarity between early stages in the development of many different animals helped convince Darwin that all forms of life shared common ancestors.

The simple line drawings are valuable but the omission of a scale showing relative size--expecially of eggs--is a serious omission that should be corrected. Developmental biology is introduced in an earlier chapter but the treatment is brief and should be reinforced at this point.

p. 630: In 1809 Jean de Lamarck had published a theory of his own...Lamarck believed that an animal which browsed on twigs and leaves of trees would stretch its neck to reach food. As a result of the stretching, the next generation would be born with longer necks.

This is the only introductory biology textbook reviewed which clearly recognizes that giraffes are browsing animals not grazers which browsed when grass was in short supply. The publisher avoids armchair hypothesizing when comparing Lamarkian and Darwinian ideas.

p. 630: First was the theory that the species of today are modified descendents of those that populated the earth in bygone ages. This was the theory of organic evolution.

While the groundwork for this theory was laid in earlier chapters, the student must wait until the last 100 pages of text before encountering the definition of biology's most important unifying concept. This should be corrected.

pp. 636-638: The Change Factor (This entire section discusses mutation and recombination as sources of variability in populations.)

Other sources of variability also exist and should be included in this review: balanced translocations, chromosome inversions and chromosome duplications to name three. Although extensive discussion of these observations may be beyond the scope of an introductory text, brief mention would forstall the creationist argument that evolution is impossible since mutations are the sole source of variability and do not increase genetic complexity.

p. 639: In any particular environment there are individuals with characteristics that improve their ability to survive. On the average, they reach reproductive age more often than do individuals lacking such characteristics. In each generation, then, we should expect a slight increase in the proportion of individuals having high viability.

This suggests evolution results in constant improvement--every generation is better suited to the environment. A more accurate presentation would suggest that natural selection results in stable populations--in equilibrium with their respective environments. An environmental change will cause the population to shift to a new set of adaptive characteristics.

p. 639: So dark moths remained very rare in the population. But after industry moved in, the dark moths in the sooty woods were eaten less often than the light ones.

A better phrase would be "after industry developed, thus reflecting the industrialization of England rather than the importation of industry.

p. 643-645: Isolation In Time...The fossil record shows that all these differences resulted from a series of many gradual changes (discussion of the horse's evolutionary lineage).

An alternative hypothesis would be that successive fossil finds represent successive populations, each of which was adapted and stable. Each population was isolated in space as well as time and could have coexisted with other populations in what is presented as the evolutionary lineage of the horse. The discussion presented in this section does not incorporate the population concepts presented in earlier parts of the chapter and seems to reflect a gradualistic view not supported by observation.

pp. 661-673: The Human Species. Human beings belong to the animal kingdom. If you cut one open, you find that the organs--heart, intestines, lungs--differ little from those of dogs, cats or monkeys. You are also able to study human nervous or endocrine systems, respiration, digestion, reproduction or muscle contraction. Again you will find chemical and physical processes similar to those found in many other animals.

This clear statement on the basic biological nature of humans is expanded in the following pages to present both similarities and differences, concluding with recognition of the uniqueness of human culture. This no-nonsense approach does not preclude other viewpoints beyond the limits of science.

pp. 673-677: Hominid History (entire section discusses fossil evidence of the human evolutionary lineage).

This otherwise good discussion would benefit by including a diagram depicting the hypothetical relationship among the various members of the hominid group. The diagram prepared for the "Ancestors" exhibit at the American Museum of Natural History is a good example of what can be done to explain this complex and growing body of evidence. Why not use the term "hominid evolution"?

Title: Macmillan Biology (1985)
Authors: Joan Creager, Paul Jantzen and James Mariner
Publisher: Macmillan Publishing Company, 866 Third Avenue, New York, New York, 10022

General Comments

There are 756 pages of text in this book divided into 10 units and 37 chapters. The opening unit (7%) introduces the field of biology, characteristics of life and scientific methods. Unit 2 (10%) develops basic chemistry and cellular biology. Heredity and genetics are covered in Unit 3 (10%) while the History of Life is given on entire unit (10%) concluding with classification. The following four units review viruses, monerans, protists, fungi, plants, invertebrates and vertebrates (37% total). Human physiology is given one unit (16%) and the book concludes with ecology (6%). The textbook's development of biological concepts is traditional and emphasizes clasification plus human physiology. The five-kingdom system of classification is used in the study of living things.

Despite traditional emphasis on classification and human physiology, this book provides numerous references to modern research and technology emerging from older, more traditional studies. Thus recombinant DNA technology is included in the chapter on virusus, amniocentesis is discussed in the chapter on human development and human genetic disorders (a term preferable to genetic diseases) are reviewed in the chapter on human heredity within the genetics unit. An altogether successful effort has been made to present a coherent summary of biological knowledge within the framework of taxonomy.

The treatment of scientific methods in chapter II is excellent, correctly emphasizing the need to ask good questions. The testability of hypotheses is stressed and shown to depend on deductions: "If this hypothesis is true then it follows that..." We regret the publisher did not use this process in designing the Laboratory Investigations. Each begins with an objective stated as an outcome rather than as a question for which hypotheses may be developed and tested. In addition, theory is rather narrowly defined as "a major hypothesis which has survived extensive testing" rather than as a grand synthesis of information about some aspect of the natural world. Explanatory power is the critical element in defining a theory, not its origin.

The basic concepts of biology are developed logically and, most importantly, reinforced several times after being first being introduced. The concepts of evolutionary theory, for example, are not developed historically but conceptually, from cells through heredity to population genetics, thus leading the student to consider natural selection as a phenomenon of populations. Only then is evidence for evolutionary change presented. In the study of the five kingdoms, two-page summary charts are presented at key points to help the student keep the plethara of information under control.

On the other hand, the publisher did have a tendency to soft pedal evolutionary theory in this otherwise excellent book. The unit on evolution is euphemistically titled, "History of Life" and includes four chapters, none of which contains the word evolution in its title; the term evolution is not defined

in the glossary. Then, in the section titled Human History, the publisher repeatedly uses modifiers such as "it is thought" or "believed" when referring to scientists' conclusions which are based on available evidence. This section also lacks a summary of the hypothesized human evolutionary lineage. Finally, there is little further discussion of evolutionary lineages in the four units devoted to surveying living things.

Specific Comments

> p. 23: Figure 1.1 (color photo of elk grazing along a riverbank): An artist might observe this scene differently from a business executive, a sports enthusiast or a scientist.

Each illustration can serve multiple purposes. In this case a note on the geographic location would help students place the scene in their growing mental map of the world. Was this photograph taken in Yellowstone National Park?

> p. 26: Figure 1.7. Red blood cells in the vein of a mouse, as shown by scanning election microscope.

It would also help student understanding if some sort of scale were added to each photomicrograph, such as a bar indicating 10 micrometers.

> p. 35: In the true nature of science, however, theories are always open to further study. Unlike a math theorem, ideas of a scientific nature cannot be proven. There is always the possibility that new observations will refute accepted theories.

This is true only if one uses a narrow definition of a theory, such as that given in the glossary: Theory--a major hypothesis that is generally accepted because it continues to survive extensive testing, generate successful predictions, and explain certain observations" (page 779). This is one of the better definitions in the books we reviewed but it falls short of that given by John A. Moore (American Zoololgy 1984, 24:474: "Theory (describes)...a body of knowledge and explanatory concepts that seek to increase our understanding of ('explain') a major phenomenon of nature." Examples would include cell theory, evolutionary theory, atomic theory in chemistry and gravitational theory in physics.

As so used, a theory cannot be falsified although parts of it may be refuted which could lead to modifications or additional theories. Gravitational theory fails to explain the behavior of objects moving near the speed of light; such observations are explained by the theory of relativity. A true theory, therefore, is as certain as anything we have in science, and is not going to be refuted in its overall explanatory power. It is time publishers clearly distinguished between possibly and probably when defining a theory. The possibility that evolutionary theory is wrong exists, but the probablity is infinitesimal.

p. 40: A valid hypothesis must do three things. First, it must be able to explain (observations)....Second, it must be testable. To devise hypotheses that are not open to experiment is a waste of time for the scientist. Finally, a good hypothesis must be able to predict new findings.

You might think of the predictions as an 'If...then...' statement.

We commend the publisher for this lucid description of the hypothetico-deductive method commonly used in science.

p. 43: Laboratory Investigation Objective:
- o To estimate the size of small objects by using the microscope.

Having just complimented the publisher for an excellent introduction to the processes of science, we must now complain the very process just described is not used in this or any other laboratory investigation. How much more exciting it would be if each objective were stated as a hypothesis with "If...then..." predictions! In this case, one might write: "If a microscope enlarges proportionally, then it should be possible to use the microscope to measure the size of small objects."

p. 55: Figure 3-7. Populations interact in various ways in a community. (photograph of a frog on a moist log).

Again, it would help the student to know the species depicted.

p. 54: Remember that organisms that interbreed in nature are members of the same species. All interacting, interbreeding individuals of one species are called a population.

These are good working definitions.

p. 203: "2. The Hardy-Weinberg Principle
...Under certain conditions, the frequencies of alleles in a population will remain constant from generation to generation....There are four conditions that must be met for the Hardy-Weinberg principle to be true.

This section presents a sophisticated discussion of this important concept, laying the groundwork for understanding evolution.

p. 215: 1. Genetic Disease.
"Genetic disorders can be looked at as a kind of vertical disease."

The term "genetic disorder" is preferred to "genetic disease." We urge the publisher to use consistently the former term.

p. 231: The variety of living things on Earth is truly astounding. How did such variety come about? This unit will explore some of the possible answers to this question. That organisms do change is a conclusion based an extensive studies of the fossil record as well as existing plants. This conclusion, however, is not shared by all scientists....Many but not all scientists feel that these conclusions answer the question of how in a satisfactory manner.

We warmly applaud the opening sentences of this introduction to the unit on evolution. However, the last two sentences raise questions. Which scientists? What are their credentials? How do they answer the opening question? Having brought up the issue, the publisher leaves it dangling with no further discussion. This passage panders to the creationist view, introduced by the publisher to meet perceived demands of the Texas adoption process. Such practice has no place in a modern biology textbook. We also note this unit is titled "History of Life," a euphemism for evolution.

pp. 257-258: Dating the Record (entire section).

This is among the best discussions of radioactive dating in any of the textbooks reviewed for Academic Biology.

pp. 274-275: A Summary of the Geologic and Biologic History of the Earth (a geologic chart).

This is a excellent chart relating geological periods and epochs, climatic characteristics and dominant life forms.

pp. 279-282: Human History (entire section).

This brief but lucid discussion of human evolution would be improved by adding a chart relating various fossil hominids. The one used in the "Ancestors" exhibit at the American Museum of Natural History is excellent.

p. 287: "For example, a common plant in the American Midwest has the species name Solanum rostratum Dunal. It is assigned to the genus Solanum. Its specific name is rostratum, the authority who described this species was Michel Felix Dunal (1789-1856), a French botanist."

This is exactly right!

pp. 291-299: The Five-Kingdom System (entire section).

This fairly extensive discussion of the rationale behind the five-kingdom system provides a logical framework which enhances student understanding.

p. 662: Figure 33-6. The human embryo skeleton consists of fibrous structures shaped like bone. Gradually the process of calcification replaces these structures with bone.

This illustration would be enhanced if the embryo's age were included in the caption.

p. 705: Figure 35-13. Chick embryo at 72 hours shows the development of a notochord.

Where? There should be black bars indicating the limits of the notochord.

pp. 765-780: Glossary of Biological Terms.

Evolution is not defined.

Natural selection is not defined.

Species: a group of organisms that have the ability to interbreed.

In addition add, "interbreed naturally and produce fertile offspring" so that this definition agrees with the text on page 54.

Title: Addison-Wesley Biology (1984)
Authors: Edward Kormondy and Bernice Essenfeld
Publisher: Addison-Wesley Publishing Company, 2725 Sand Hill Road, Menlo Park, California 94025

General Comments

The 7[illegible]ages of text are divided up into eight units and 26 chapters. Unit 1, an Introduction to Living Things (11%), reviews the range of biological concerns and provides a brief overview of living things. Unit 2 (16%) considers cell structure, metabolism and concludes with energy transfer. Unit 3 (18%) reviews basic body processes or physiology. Unit 4 (11%) covers regulation, both chemical and nervous. Unit 5 (13%) opens with DNA, RNA and protein synthesis, then covers reproduction and plant and animals development. Unit 6 (12%), "Change Over Time," discusses heredity, chromosomes and genes and evolution. The environment and ecology are in Unit 7 (10%) and the last unit covers behavior, health and disease (8%).

This book presents a rigorous review of the major concepts of modern biology organized in a functional manner. Students using the textbook for a year-long course in biology will derive a solid understanding of the principles on which biology is founded, with examples of their application drawn from all levels of living things. The review questions for each chapter stress understanding these principles and require students to read, understand and analyze the chapter contents; picking out isolated facts for simple regurgitation does not suffice.

Scientific method is presented in chapter III as part of the unit on cell structure and function and immediately applied to specific examples of research. The presentation is accurate although it could be improved by stressing that a hypothesis leads to a deduction which can be tested through observation, and by adding the elements of publication and verification. The conclusions of scientists are uniformly presented as conclusions with supporting evidence generally provided; the use of qualifying terms is avoided, such as "scientists believe" and "scientists think."

Despite these good qualities, the theory of evolution is not woven into the fabric of biology. Although plant and animal classification are restricted to a single chapter, nowhere is it pointed out that classification as we practice it would not work except for descent with modification. Some 42% of the text is devoted to considering how various organisms go about the business of living, but the evolutionary basis is never discussed or mentioned.

Chapter 21, the single chapter devoted to evolutionary theory, is divided into three main parts: how life might have begun; evidence for evolution; and mechanisms of evolution. The discussion of the Oparin or heterotroph hypothesis, is lucid, but the presentation falters on geological concepts which are sketchy at best. Modern evidence for evolution--protein and DNA comparisons--is not presented. Even the discussion of the transitional fossil Archaeopteryx is too brief to be of any real value. Darwin's hypothesis of natural selection is briefly but accurately described and the chapter concludes with a final rush through The Modern Synthesis of evolutionary theory. One cannot escape the

suspicion that the publisher has sequestered all evolutionary content into one chapter where it can be conveniently ignored by some teachers in order to allow students to complete a high school biology course without ever being exposed to the major unifying concept of modern biology.

Specific Comments

p. 9: Each kind of organism is called a species. Members of a species are very much alike and are able to mate with each other.

Members of a species constitute a population of naturally interbreeding plants or animals. This concept needs to be introduced, otherwise how does the teacher account for tiger-lion hybrids found in zoos? These felines have overlapping ranges yet their hybrids are unknown in nature.

p. 26: Consider the Arctic fox as an example of how species may change. Its thick winter coat helps it survive the bitter cold of winter. Suppose that some time in the past, not all Arctic foxes had thick coats. Instead there may have been variations in the thickness of their coats. Some may have had thick ones and others thin ones. It is possible that one winter the weather was so severe that only the thick-coated foxes survived. In the spring the surviving foxes reproduced and passed on the thick-coat trait to their offspring. Because the thin-coated foxes died of the cold and did not reproduce, most Arctic foxes then had thick coats. This is a possible explanation for how changes occur in species over time.

This paragraph is armchair hypothesizing. For a hypothesis to be scientific, it absolutely must be testable; this one isn't and should not be presented as science. Better to point out that the Arctic fox is closely related to foxes which live at higher latitudes, and that the Arctic fox might represent a subpopulation carrying with it certain variations that permitted survival and continued to accumulate. There is more to surviving in Arctic regions than simply having a thick coat, as the photograph illustrates. But why introduce such a sophisticated concept so early? Why not just raise a question based on observation?

p. 38: In biology, related organisms are believed to have the same or common ancestors. Relatedness is the basis for classification.

Scientists do not "believe" but reach conclusions based upon evidence. This sentence would therefore be better written as: "Based upon the accumulated evidence presented in this section, scientists have concluded related organisms have descended from common ancestors. Relatedness is the basis for classification."

p. 63: 2-43 The animal kingdom consists mostly of insects...
(Illustration shows the relative importance of major animal taxons.)

This illustration would be improved if the approximate number of species in each taxon were added.

p. 97: Figure 3-11. Steps in the Scientific Method (illustration).

This illustration has several problems:

(1) The control--"Leaving nuclei in 20 cells. Grow cells."--is not a proper control. Since the nuclei have been removed from the experimental set, the correct control is to operate on--but not remove the nuclei from--the control set. Otherwise, the experiment may only demonstrate that operated cells die.
(2) The hypothesis would be better stated in an either/or form: "Either a cell requires a nucleus in order to live or it does not." From this the experiment as modified in (1) follows.
(3) Under "Collect and Analyze Data," it is important to establish criteria for judging whether cells shall be scored as alive or dead.

p. 209-432: Unit III, Basic Body Process, and Unit IV, Body Regulation (entire sections).

These extensive sections, 42% of the text page total, consider how various types of organisms go about the process of living. Examples are drawn from various taxonomic groups, in effect presenting a comparative picture of physiology. However, the evolutionary basis for this otherwise excellent review is never discussed or even mentioned. Why do organisms use similar solutions to common problems? Why can we study the physiology of nerve conduction using the giant axon of the squid and expect the results to apply to human nerves? Why can we classify organisms into nested categories of relatedness?

p. 259: The Evil Spirit in Milk.

Use of such a flashy term may discourage milk drinking among young people. Besides, such a metaphysical term does not belong in a science text.

pp. 576-584: 20.3 The Nature of Genes (entire section).

This section is weak on human genetics and biotechnology.

pp. 590-592: Redi's Experiments (entire section).

This discussion would be improved by following the scientific process as presented on page 96. For example, Redi's hypothesis is clearly stated but the deduction upon which the experiments are based is not. It should also be noted that Redi published his results and others verified his observations.

p. 589: 21.1 Theories About the Origin of Life (entire section).

The publisher has provided an excellent discussion of this important topic. The development is logical and treatment succinct.

p. 594: Formation of the Earth. Most geologists and astrophysicists estimate that our planet was formed about 4.6 billion years ago from the condensation of a huge cloud of dust and gases that whirled around the sun.

Because of its importance, the publisher should provide evidence of how this estimate is derived. As presented, the figure is dogmatic.

p. 597: Miller and Urey's Experiment. In 1953 Stanley Miller and Harold C. Urey, at the University of Chicago, tested the heterotroph hypothesis for the first time.

Miller did not test heterotroph hypothesis; rather, he tested a prediction of the hypothesis.

pp. 589-618: Chapter 21, Change Over Time.

This chapter begins well but concludes with a barely adequate discussion of evolutionary theory. There are serious omissions; there is no mention of human evolution, its supporting evidence or of well-established evolutionary lineages among mammals such as the horse. Nor is modern evidence of evolution mentioned including comparative protein and DNA studies which strongly confirm existing taxonomic relationships. The most serious objection to this treatment of evolutionary theory, however, is that it is confined to this single chapter, with no other mention of evolutionary theory or its implications in any other section of the book! Obvious connections are never mentioned: for example on pages 644-646 where factors limiting population growth are discussed, and on page 667 where niches and habitats are discussed. Evolutionary theory and ecology were developed hand in hand and their forced separation is inexcusable.

p. 601: The Age of a Fossil.

This discussion of the carbon-14 dating method is fine as an illustration but has no relationship to the multimillion year ages being discussed in table 21-1. It should be augmented with a discussion of the methods used to determine the age of igneous intrusions into sedimentary rock. Although the second paragraph of this section touches on the argon-potassium method and refers to its use to date "the age of the rock" around fossil-containing strata, the technique needs amplification because of its importance.

p. 603: Relationships Among Species (entire section).

This discussion of Archaeopteryx is too brief to be of any real value. The evidence for the origin of birds is far more extensive than a single fossil, and includes many anatomical similarities. Archaeopteryx provides a confirmation since it shows a form with both dinosaur-like and bird-like characteristics; a true intermediate or transitional form. "...Other fossils exist that show characteristics of different groups." This point should be illustrated, perhaps with the horse lineage. The publisher should consider enlarging this section on relationships since they are not discussed in any other section of the book.

pp. 562-721: Glossary.

Amniocentesis is not defined.

Evolution: the changing of species over time.
This definition is incomplete since it does not include descent with modification.

Natural selection is not defined.

Species is not defined.

Theory is not defined.

Title: Scott, Foresman Biology (1985)
Author: Irwin Slesnick, LeVon Balzer, Alan McCormack, David Newton and Frederick Rasmussen
Publisher: Scott, Foresman and Company, 1900 Lake View Avenue, Glenview, Illinois 60025

General Comments

The major themes of this textbook are classification of organisms (40%) and human structure and function (16%). Minor themes are chemistry and cell biology (13%), genetics (7%), evolutionary theory (8%) and ecology (8%). It is a traditional textbook which does an honest job of presenting its limited scope.

An opening paragraph (page 10) clearly distinguishes between explanations derived by science from those derived from religious sources: "Since such acts of special creation would be supernatural events, they cannot be tested scientifically." Although the ensuing explanation of the scientific method is outdated, it could easily be improved by stressing that deductions from hypotheses lead to experiments which provide data that either agree with or falsify the hypothesis. A theory is more than a verified hypothesis, as the text suggests, but the definition should be broadened to include the notion that a theory explains a major natural phenomenon. The publisher has generally avoided the trap of couching scientists' conclusions in terms which make them seem like mere opinions.

Despite a heavy emphasis on classification of living things, evolutionary theory is not woven into the discussion. Thus the early reptiles are dismissed with a brief note. A diagram illustrating the proposed lineages between dinosaurs, reptiles, mammals and birds would be far more useful. Discussion of cells fails to note the proposed relationships between procaryotes and eucaryotes, nor does the DNA model coverage note the discovery of DNA as the universal hereditary material is strong evidence for descent from a common origin of life. Likewise, the discussion of classification based upon the five kingdoms is not related to evolution. Taxonomy is based upon nested categories of relatedness derived independently of evolutionary theory yet providing strong evidence for descent with modification.

The geological history discussion begins by reviewing how moon rocks are dated but omits the assumption that the moon and earth were formed at the same time. The discussion of fossilization is incomplete since it fails to note that minerals have replaced much of the original animal and plant material. This inadvertently emphasizes "young fossils," a trend reinforced in the discussion of radioactive dating using only carbon-14 methodology. This requires carbon to be present and has a 50,000 year limit. However, the graphic presentation of the geological time scale and its visualization by means of comparison to a tall building is commendable. The text also contains a good summary of the main geological time record features.

Both classical and modern evidence for evolution is presented, although prefaced by a curious sentence repeated in several variations: "Of course the observations of beak structure do not prove evolution (page 208)." "However,

homology does not prove evolution. Nobody has actually seen reptiles with forelimbs give rise over millions of years to birds with wings or whales with flippers (page 209)." Science advances by failing to disprove hypotheses, not by proving them; the hypothesis of evolution is accepted because it has not been disproved. Evidence for human evolution and proposed evolutionary lineage are not presented.

Specific Comments

p. 10: Scientific Methods (entire section).

This description of the scientific method is outdated. A better description of the hypothetico-deductive method would include these elements:

- A question is framed which can be tested by observation.
- A hypothesis is derived by induction, which must be testable through observation.
- Certain consequences of the hypothesis follow: if the hypothesis is true, the deductions are true.
- The deductions are tested through controlled observation (experiment). Those which fail to be supported are discarded. The surviving hypothesis is accepted as tentatively true.
- The more deductions tested and confirmed, the more likely the hypothesis is true.
- The new knowledge is shared with other scientists by publishing the results.
- The work is verified by scientists working independently.

p. 10: Humans have asked questions about the origin of life since the beginning of recorded history. Religious answers vary to such questions as how and when life originated on Earth. One common belief is that a Divine Being made all living things. Since such acts of special creation would be supernatural events, they cannot be tested scientifically. Supernatural events are beyond the ability of humans to repeat, to control and detect with their senses.

Biology deals with the scientific study of life. This statement means that biologists gain knowledge by observing and testing natural events under controlled conditions. Other ways of knowing about life can be equally valid. But biology deals only with the scientific methods that are used to learn about life (emphasis added).

These two paragraphs clearly distinguish explanations derived by science from explanations derived from religious sources. The definition of science implied in the second paragraph firmly links scientific knowledge to observation. However, the underlined sentence leaves us puzzled. As a reviewer asked, "Does it mean that it has been shown that there are means other than observing and testing nature that are equally valid?"

p. 10: If continued testing supports the conclusions of a hypothesis, the hypothesis may eventually be called a theory.

This is an inadequate definition of a theory which fails to note that a theory represents a grand synthesis of information about some aspect of the natural world. Cell theory is an example.

p. 15: A Five-Kingdom Classification System (entire section).

Introduction of this modern system is commendable, as is inclusion of the diagram on page 16. However, having introduced Oparin's hypothesis, why isn't the concept of the interconnectedness of life included in this discussion of the five kingdoms? Margulis has made an important contribution by suggesting the eucaryotes owe some of their organelles to symbiotic procaryotes. This point is made on page 271, but might also be made here to continue development of the story of earth-life.

p. 19: Many scientists think that the ancestors of the cyanobacteria gave off enough oxygen to greatly increase the oxygen content of the earth's atmosphere. This increase probably made life possible for oxygen-breathing organisms.

Scientists don't "think" or "believe" but rather hypothesize and deduce based upon evidence. These sentences should be rewritten to reflect this viewpoint with some of the evidence presented.

pp. 35-37: 2-1 The Primates, Groups of Primates (entire page), "Physical Traits of Human (entire pages).

This summary of the order Primates is helpful to the student. Unequivocally including humans in the order Primates is commendable, as is the excellent comparison of human and gorilla anatomy. However, the discussion emphasizes differences rather than similarities. None of the modern evidence for close relationship is presented, such as DNA studies and similarity of protein structure. Humans and great apes are more alike than foxes and dogs. The Review It questions also emphasize differences rather than obvious similarities.

pp. 196-197: (Archaeopteryx illustration and associated text).

The illustration of Archaeopteryx is exceedingly well done, shows great detail, and was undoubtedly included at great expense to the publisher. But to what avail? The discussion of this important transitional fossil on page 197 is trivial. What were its ancestors? What should we expect to find in a transitional form between dinosaurs and birds? Does Archaeopteryx fit the bill? The discussion also implies that because it had feathers it must be classed as a bird; this is true only of modern forms and does not hold for ancient forms like Archaeopteryx Our classification system, based on differences, excludes intermediate forms; this is a fault of the system, not the fossils.

p. 198: Fossils give us indirect evidence of evolution. For example, you may have seen or handled fossils, so you know they are real objects. But seeing a fossil is not the same as seeing the process of

> evolution. So the fossil record provides scientists with indirect evidence of evolution. In the first part of this chapter you will learn about indirect evidence of evolution. The final lesson describes some direct evidence of evolution.

This paragraph gives the student a confused understanding of the importance of fossils; they are phenomena about which we may make observations, which may then be explained by a theory such as that of evolution. Whether or not one can "see" the process of evolution is irrelevant to the discussion of fossils. All observations are indirect: no one has ever seen an atom and all of the evidence that we have about atoms is indirect.

> p. 198: Usually, fossilization is not as complete as in the above examples. Most organisms die and decay without being fossilized. When fossil formation does occur, it is usually the hard parts of an organism that are preserved. Skeletons, shells and tree trunks often resist decay long enough for this process to take place.

This discussion of fossilization is incomplete since no mention is made of the fact that in most cases the original animal and plant parts have been replaced by minerals. Fossils are rocks cast in the form of the original material. This omission is serious because the previous paragraph focuses on recent fossils which retain some of the original molecules and a later section on dating fossils covers only carbon-14 dating that is useful only for fossils less than 50,000 years old. The total effect is to leave the student with the impression that fossils are of recent date.

> p. 200: Radioactive Dating of Fossils (entire section).

Although accurate, this discussion of the carbon-14 dating methodis irrelevant to the general discussion because it requires original carbon to be present in the fossils. It will not work for the vast majority of fossils which are mineral casts. In practice, sedimentary strata are dated by finding igneous intrusions within the strata which can be dated using other isotope ratio methods.

> p. 202: 3 The oldest parts have only fossils of very simple organisms. Recent portions have fossils of more and more complex organisms

This sentence is misleading. "The oldest strata..." should be used because the term "parts" has little meaning in this context. Also, the term "complex" is too broad a generalization; what does it mean? Were dinosaurs less complex than carnivores? Or sharks less complex than modern fishes?

> p. 208: Of course, the observations of beak structure do not prove evolution. The function of a theory in science is to explain as many observations as possible. In this case, the theory of evolution seems to be a reasonable explanation for Darwin's observations.

This sentence needs to be written to agree with the modern view of the scientific method: the observations of beak structure fail to disprove the theory of evolution by means of natural selection. Publisher might substitute:

If the hypothesis of evolution by means of natural selection is correct, we should expect to find recent descendents of a common ancestor resembling each other closely while expressing specific adaptations. This is precisely what we find in the case of Darwin's finches.

p. 209: However, homology does not prove evolution. Nobody has actually seen reptiles with forelimbs eventually give rise over millions of years to birds with wings or whales with flippers. But the theory of evolution does explain homologies.

The publisher is intent upon denying evolution can be proved at the expense of the student's understanding of how science really works. Homology could not possibly prove evolution, but its absence would disprove the hypothesis of evolution.

If the hypothesis of evolution is true, we should expect to find that members of a taxonomic unit, such as chordates, share a common ancestry and that this should be reflected in their structure. Homology of forelimbs is an example of such relationship.

This paragraph should be rewritten, as suggested. The phrase, "Nobody has ever seen..." is irrelevant.

pp. 212-213: 9-4 Other Indirect Evidence (entire section).

This section should be rewritten in the form of a question: "If the members of a major taxonomic unit share a common ancestry, that should be reflected in their embryonic development." Moreover, introducing a complex subject such as vertebrate kidney development without appropriate background is pedagogically unsound. At the very least there should be a diagram showing the embryology of kidney development, but a better solution is to use some other aspect such as the gill arches. The term "indirect evidence" is misleading as all evidence is indirect.

p. 213: The pattern of similarity in embryonic development does not mean that a bird embryo goes through a fish and a reptile embryo stage. It also does not mean that birds have evolved first from fish and then from reptiles. But it does suggest that very young bird embryos are similar in some ways to very young embryos of related organisms. Genetic differences that show up during the development of different species and groups are collections of such genetic changes. Biologists think these changes have been accumulating for millions of years.

This is a confusing paragraph which should be rewritten to reflect accurately the modern scientific view. To a certain extent bird embryos do go through a fish and then reptilian embryonic stage. The publisher has already given evidence attesting to this with respect to kidney development. If this does not mean birds have evolved first from fish and then from reptiles, what does it mean? In fact, there is overwhelming evidence this is the correct lineage of birds. The accepted explanation for the similarity of embryonic development among vertebrates is that evolution is serendipitous and works with

what is available. Thus, gill arches which form bony arches in fish are found to form parts of the mammalian ear. The genes controlling early development are very similar in all vertebrates and diverge only at later development stages.

p. 214: Again, vestigial structures do not prove evolution. But they do provide evidence that organisms with vestigial structures have common ancestry with organisms that have functional homologous structures.

The paragraph inaccurately reflects the scientific viewpoint of the nature of proof. It should be rewritten in the manner suggested for similar chapter passages.

p. 215: Evidence from Similarities Based on Biochemical Tests (entire section).

The inclusion of modern biochemical evidence is commendable. But having raised the issue of DNA similarity, the publisher should enlarge the section and provide the evidence linking human DNA with that of great apes. Comparative DNA studies strongly and independently verify the taxonomic categories which were developed by early biologists who believed all life had been created at one time.

p. 216: Evidence from the Geographical Distribution of Subspecies (entire section).

This sort of evidence for a prediction derived from evolutionary theory is not usually presented in an introductory text and its inclusion is to be commended. It could be strengthened by stating the hypothesis as follows: "If the theory of evolution by natural selection is correct, we should expect to find the process of speciation under way, and if a species is examined over its whole range we should expect to find subpopulations or incipient species." This section might be better placed in the following chapter covering mechanisms of evolution.

pp. 228-229: Early Attempts to Explain the Mechanisms of Evolution (illustrations on pages 228 and 229: the evolution of giraffes).

The evolution of the giraffe's long neck is a favorite illustration for introductory biology textbooks, even though it is virtually worthless as an illustration of natural selection. To begin with, the giraffe is a browsing animal not a grazing one, thus the sentence on page 229, "when grass was in short supply, more food was available to long-necked giraffes," is inaccurate. For another, the neck of the giraffe did not evolve independently of the rest of its body: longer legs and an improved circulatory system (to withstand the enormous hydrostatic pressure of an 18-foot neck) all evolved together. The illustration, however, implies that only the neck evolved. Finally, the proposed scenario (Darwin's explanation) is untestable and therefore an unscientific hypothesis. It is armchair science at its worst.

pp. 483: Early Reptiles (entire section).

This discussion sorely needs a diagram illustrating proposed lineages of dinosaurs and reptiles.

pp. 686-695: Glossary.

Evolution: The theory that states changes occur in the genetic make-up of a population over a period of times."

This definition is incomplete without noting descent with modification and species origin.

Hypothesis is not defined.

Natural Selection is not defined.

60 BIOLOGY TEXTBOOKS

Title: Heath Biology (1985)
Authors: James McLaren and Lissa Rotundo
Publisher: D.C. Heath and Company, 123 Spring Street, Lexington, Massachusetts 02173

General Comments

This 743-page textbook is divided into eight units and 50 chapters. Development of the subject begins with a review of the scientific method plus basic chemistry and cell theory (17%). Unit 2 (14%) moves through genetics to evolution (one chapter, 20 pages) and ends with classification. Using the five-kingdom system, the next four units (41%) review the world of life. Human physiology occupies Unit 7 (19%) and concludes with behavior and ecology (9%). The textbook is a traditional treatment with 41% of its pages devoted to classification and description, 19% to human physiology and 40% to various other biology topics. The five-kingdom system is used, a plus.

This textbook manages to cover many modern biological concepts including gene splicing, human evolutionary lineage and genetic disorders but at the cost of a heavy textbook which students are unlikely to take home. One answer is to reduce the 320 pages presently devoted to classification and comparative anatamy to a more reasonable 150 pages or fewer. We also found excessive introduction of new words and terms which have single page citations, indicating they are used but once. Emphasizing classification plus excessive vocabulary results in a textbook which tells scientific conclusions without revealing the process by which these conclusions were reached.

Nevertheless, the textbook does contain a good discussion of scientific methods and does properly define theory. While the chapter Review questions require mere regurgitation, the Interpret and Apply and Challenge sections do stimulate thinking. Except for a few places, the publisher fails to state what is not known in addition to what is known. The viewpoint that science is a never-ending search full of surprises and often serendipitous advances should also be developed.

The single chapter on evolution is without doubt the book's most poorly written. The history of earth-life contained in the fossil record receives cursory treatment: a mere five paragraphs. The chapter does contain a four-color two-page geological chart but since the concepts it contains are never developed, it becomes just another list of vocabulary words. The origin of life via heterotrophs, the origin of autotrophs and multicellular organisms would be better integrated into other chapters.

Having avoided reviewing the vast fossil evidence for evolution, the publisher nevertheless does present a reasonable discussion of Lamarck and Darwin's hypotheses. But then instead of using the "if...then" approach first introduced in chapter 1, the publisher resorts to merely listing evolutionary evidence. Comparative protein studies are mentioned but not properly developed, while comparative DNA studies are ignored. Speciation--a key concept--is inadequately developed. In subsequent chapters on classification, evolutionary

lineages are either poorly discussed or altogether ignored. Thus a teacher intent on avoiding evolutionary theory as an explanation of modern life could easily do so by simply ignoring chapter 14.

The Texas disclaimer in the preface should be removed if this book is adopted. ("Keep in mind that evolutionary theories (sic) conform to the criteria set for a scientific theory. They are not to be treated as fact.") As far as science is concerned, evolutionary theory, like cell theory, should be written in the singular since it designates a large and growing body of knowledge, not an unproved idea.

Specific Comments

p. 3: 1-1 Characteristics of Science (entire section).

This section provides a sound introduction to scientific methodology. We recommend one minor change: "Other scientists using similar methods should produce the same observations" (rather than "reach the same conclusion"). Two scientists may reach different conclusions from the same data but both should generate the same data.

p. 9: A good hypothesis is stated in a form that suggests a way to test the explanation. One such form is an "if...then" statement.

This is one of the best definitions of a hypothesis we found among the biology textbooks reviewed.

p. 12: The word theory is defined clearly in science...a scientific theory is an idea that is widely accepted as a correct explanation because it is supported by many observations and experiments and continues to explain many new observations.

Notice also that scientists generally avoid the use of the word proof. Evidence can support a hypothesis or a theory, but it cannot prove a theory to be true.

The publisher has provided an excellent description of a theory but should add that, as predictions of a theory are repeatedly tested and supported by observation, the theory takes on a degree of certainty approaching truth. Although the possibility exists that contradictory evidence may one day overturn the theory, the probability of this happening is slight. Thus the atomic theory, cell theory and evolutionary theory are very well established and are as certain as any explanations we have in science.

p. 15: Keep in mind two things as you study biology. First, the facts and theories presented here represent the efforts of thousands of scientists over hundreds of years....Second, biology is a constantly growing and changing body of knowledge.

This viewpoint, that science opens "vast vistas of unanswered questions" while building on past knowledge, is warmly applauded. We regret the publisher did not present biological knowledge from this viewpoint.

p. 24: An adaptation is a structure or behavior that allows survival in a particular environment.

This is oversimplified and smacks of vitalism. The publisher would serve students better by pointing out that earth-life provides numerous examples of organisms which are wonderfully adapted to a particular way of life. It is perfectly acceptable for a science textbook to marvel at nature; the problems only start when explanations derived from religious or other nonscientific sources are put forward as though they were science. A key question should be raised here: "Why are organisms so marvelously adapted to particular ways of life?"

p. 26: Biogenesis: Life Produces Life (a discussion of work by Redi, Needham, Spallanzani and Pasteur; entire section).

This section provides a lucid discussion of experiments designed to test the hypothesis of biogenesis. The publisher uses concepts developed earlier in Chapter 1 on scientific methods.

p. 53: Figure 4.6. The element magnesium is present in chlorophyll, the substance responsible for the green color of leaves (illustration of verdant forest's fern-covered floor).

Illustrations such as this should always be captioned to indicate the actual habitat and its geographic location.

p. 68: Figure 5.2. Cells come in a variety of shapes and sizes. (The illustration depicts what appear to be paramecia, Tetrahymina and striated muscle.)

A scale of size should routinely be included in every photomicrograph used in a science textbook. The varied optical and staining techniques used in these photomicrographs are neither referenced nor explained. Finally, muscle tissue is a syncytium and a poor example of a cell; white blood cells would be better.

pp. 72-75: 5-5 Cytoplasm and Organelles (mitochondria, endoplasmic reticulum, plastids, golgi bodies and so forth are discussed and illustrated).

The text should point out that several of these organelles, notably mitochondria and plastids, contain their own DNA and protein synthesizing systems, strongly suggesting a once independent existance. This should be related to evolutionary history and hypotheses on the origin of eukaryote cells.

p. 104: Figure 7.12. The chlorophyll and accessory pigments give each leaf its characteristic color (illustration of a varigated coleus leaf).

The caption should always include the name of the species used in the illustration.

pp. 170-173: Treating Genetic Disorders (discussion of treating phenylketonuria, genetic counseling, amniocentesis and prenatal treatments).

Including this discussion within a biology course context is commendable and will help students understand both the limits and value of such techniques increasingly used in medical practice. The use of the term genetic disorders instead of disease also commendable.

pp. 182-184: Artificial Methods of Genetic Control (a discussion of polyploidy, plant cloning and recombinant DNA technology).

The publisher has provided a reasonably good discussion of this important technology.

p. 189: Biologists now define a species as a group of organisms that can mate among themselves and produce fertile offspring.

The emphasis of this definition on an interbreeding population is good and could be improved by adding naturally interbreeding.

p. 190: Only the Florida keys a tine (sic) form of this deer grows to only 110 kilograms.

This sentence needs editing before it will make sense.

p. 193: 13-4 The Hardy-Weinberg Principle. (The text and figure 13.5 use the example of drawing brown or white marbles from a container to illustrate the concept of a gene pool.)

This teaching model will work only if it is stipulated that the chosen marble is returned to the pot after each draw so the frequency of each color marble in the pool is kept constant.

p. 201: Evidence indicates that earth is about 4.5 billion years old.

What evidence? Considering its importance, this section should be expanded and evidence for the 4.5 billion year figure provided.

pp. 201-204: 14-1 The Fossil Record (a review of the nature of fossils and isotope dating methods).

This section is extremely weak and should be expanded to give the concepts proper development.

Most fossils are mineral casts or impressions of the original organism; this is not clear from the discussion which emphasizes a woolly mammoth fossil frozen in permafrost.

The nature and characteristics of the geologic column are not adequately developed.

The discussion of radioisotope dating methods is incomplete. The method does not work for sedimentary rocks, forcing geologists to measure igneous intrusions which give a maximum age for overlying sedimentary rock.

> p. 205: Wires entering the top of the flask created electric sparks (discussion of Miller's experiement to test the premises of Oparin's hypothesis).

The wires did not create electric sparks; a high voltage electric source connected to the wires created an electric spark across the gap between the wires. Sloppy writing.

> p. 207: No one knows why fossils of multicellular organisms appear so suddenly in the fossil record. One hypothesis is that earlier organisms had soft bodies that did not fossilize easily.

We can never "know" in the sense implied by this sentence--but we can generate some testable ideas. The text suggests one and there are others. Recent investigations of Ediacarian rocks reveal an extensive fauna of flattened, worm-like creatures quite unlike later forms. Furthermore, the appearance of multicellular organisms was hardly "sudden" having taken some 15 million years. This section reflects sloppy writing combined with inadequate research.

> p. 209: Lamarck's theory of evolution did not convince many scientists of his day.

To begin with, this is an improper use of the term theory (described on page 11) to describe a hypothesis. How was Lamarck's hypothesis ultimately falsified? It would be worthwhile adding a paragraph discussing experiments which eliminated his idea.

> p. 211: The fastest cheetahs would be the most likely to catch food. They would survive and ultimately reproduce. Thus only the fastest cheetahs would survive to pass their traits on to the next generation.

Meanwhile, what of the antelopes upon which the cheetahs prey? They, too, are evolving, accumulating such traits as long, light legs, eyes set high on the skull and so forth. Predator and prey evolve together, leading to a balance where both survive. This concept should be discussed.

> p. 212: Darwin's book, The Origin of Species, contained a great deal of indirect evidence to show that evolution had occurred.

What would constitute direct evidence? The concept has no meaning in science: all evidence is indirect in the sense that all observations must pass through the filter of our senses and reach us after the event which propagated them, whether time is measured in microseconds or millions of years. All knowledge of atoms is indirect. This section should be rewritten to reflect scientific practice.

p. 213: Biologists have evidence whales evolved from four-legged animals that lived on land. When whales entered the water, rear legs would have been a disadvantage.

This poorly written passage evokes images of a cow-like creature jumping into the water and turning into a whale. The ancestor population which gave rise to whales had legs lost in subsequent populations, thereby leading to modern whales. It might have taken place in stages as the text suggests but one can also hypothesize a one-step developmental change, as in the mutation phocomelia (seal-like limbs as induced by the drug thalidomide).

p. 213: Figure 14.14 (line drawings of stages in the embryology of a fish, bird and primate).

This diagram is too small to be of much help. A scale should also be provided so the student will not conclude all three eggs are the same size. The accompanying text description is extremely poor.

p. 213: 14-10 Evidence from Biochemistry and Genetics. (Two brief paragraphs discuss comparative amino acid sequences of proteins and note that DNA is the universal heredity molecule.)

This is a totally inadequate discussion of the major evidence of evolutionary relationships. A modern textbook should contain diagrams and a detailed discussion. Comparative DNA studies are missing.

p. 215: In the 3.5 billion years since life arose on earth, evolution has produced an enormous variety of living things. Millions of species have evolved successfully while others have become extinct.

The second sentence incorrectly implies extinct species were unsuccessful. Dinosaurs as a group were extremely successful. The publisher would do better to simply say we do not know why the fossil record indicates mass extinctions at several points in earth's history. One hypothesis gaining credence is an extended winter produced by dust thrown up by an asteroid impact. This section should be rewritten.

p. 215: Natural selection can lead to the formation of new species or speciation. Speciation often occurs when part of a population becomes isolated from the rest.

Genetic drift, introduced earlier in discussion of the Hardy-Weinberg law, should be reintroduced here and expanded. Differential selective pressures are only part of the speciation story.

p. 222: Notice that in binomial nomenclature, the name of the genus is capitalized and appears first. The species name follows and is not caputalized.

The specific epithet or name follows the genus name; together they are the species name.

p. 467 (referring to a coelocanth): "Many scientists think that this fish is descended from a common ancestor of the first vertebrates that walked on land with four legs" (emphasis added).

Using modifiers such as "think" and "believe" to describe scientists' conclusions is inaccurate and leads students to view such conclusions as just opinions. There should be a diagram of lobefin anatomy to show how it relates to higher vertebrates, thus providing evidence for this conclusion.

pp. 494-497: The saurischians had hip bones much like modern lizards. The ornithischians were dinosaurs that had hip bones similar to modern birds.

Figure 33.15. The evolutionary relationships of reptiles.

Having introduced these two important groups of dinosaurs, why don't they appear in figure 33.15? The evolutionary relationships are touched upon and then dropped, leaving the student with confusion and new vocabulary words.

p. 501: Feathers alone can identify an animal as a bird.

This is only true of modern birds. If we were classifying life 135 million years ago we would have to use a different set of diagnostic characteristics. This should be pointed out to students.

p. 529: (referring to horse evolution): Actually, many of the intermediate forms of horses are found in rocks of the same age. This indicates that they lived at the same time and that one could not have evolved directly from the other.

This conclusion does not follow. There is every reason to expect an ancestor species to coexist with a descendent species modified to allow it to exploit a separate niche. Darwin's finches are an example of such a set of species, as are the variety of African antelopes. This section reflects the views of creationism rather than of science.

p. 537: Of all the primates, apes are closest in structure to humans....But there are uniquely human characteristics that separate people from apes.

The publisher doth protest too loudly. Every species has unique characteristics which separate it from all other species, otherwise classification would be impossible. The remarkable observation, which the textbook avoids, is that humans and apes are more similar and share more common traits than do foxes and dogs. These shared traits should be discussed, including the remarkable match between the DNA of humans and primates.

p. 545: Figure 36.11 shows two interpretations of human evolution....These hypotheses demonstrate that anthropologists disagree about which hominids descended from which ancestors.

By overemphasizing disagreement, the publisher hides legitimate scientific controversy from students. The evidence is scanty and hypotheses do go beyond available fossil finds, but this uncertainty is normal at the cutting edge of scientific inquiry. Students should have this uncertainty explained while being encouraged to follow the unfolding story in years to come. Don't cut them off at the pass.

pp. 750-774: Glossary.

Theory is not defined.

Title: Biology Living Systems (1983)
Author: Raymond F. Oram
Publisher: Charles E. Merrill Publishing Company, P.O. Box 508, 1300 Alum Creek Drive, Columbus, Ohio 43216

General Comments

The 699 pages of text are divided into eight units and 35 chapters. The book opens with a review of biology and moves through simple chemistry, energy and cell structures (Unit 1, 13%). Unit 2 covers heredity (12%) while Unit 3 called Changes reviews evolution, speciation and classification (8%). Units 4 and 5 (20% total) review the five kingdoms and Unit 6 covers plant anatomy and function (8%) . Unit 7, the longest (23%), essentially covers comparative animal physiology with an emphasis on humans. The final unit (16%) covers ecology. The textbook is a hybrid between a phylogenetic review and study of biological principles.

The concept of theory is not well presented in this text either in the chapter on scientific method or in later development of specific theories. Evolutionary theory is not woven into the fabric of biology despite numerous opportunities offered by the content organisation. For example, evolutionary implications of classification are not elaborated in the units dealing with taxonomy.

The major discussion of evolution, both evidence and mechanisms, occurs in two chapters. Modern evidence for evolution (comparative DNA and proteins studies) is not well developed. However, the fossil evidence for human evolution is both straightforward and accurate. Darwin's hypothesis of natural selection is accurately presented.

Nevertheless, the publisher goes to considerable lengths to present the conclusions of scientists as opinions, presumably to avoid presenting evolutionary theory in a dogmatic manner. Unfortunately, this distorts scientific knowledge and leaves students with the mistaken impression evidence doesn't matter. The Texas disclaimer found in the preface should certainly be removed if this book is adopted.

The textbook does contain several examples of inaccurate if not sloppy writing which result from "writing down" the text to the presumed level of student comprehension. Some marginal notes printed in blue are particularly irksome.

Specific Comments

p.iii: Preface. Evolution, for example, is treated as theory rather than as fact.

This statement inaccurately relates theory and fact and should be corrected. Theories are dependent upon facts for verification and never become facts although they maybe known with great certainty.

p. 21: The late 1800s was an exciting time for biology.
(Various discoveries are listed.)

Why is evolutionary theory omitted from this list? No other theory in biology has had such a profound effect on human thought.

p. 22: A fact is something about which there is no doubt. It is a fact that this paper is white.

This description of a fact is poorly stated. The essence of a scientific fact is that it is an observation that can be repeated by anyone and upon which there is general agreement. We can agree that "this paper is white" while recognizing close observation would reveal degrees of whiteness in comparison with other papers.

p. 23: He (Fleming) assumed that the chemical moved throughout the clear zone (discussion of the discovery of penicillin).

He hypothesized a chemical diffused throughout the clear zone, which led him to deduce it should be possible to isolate it from the growth medium. It was and he did, confirming his hypothesis.

A hypothesis leads to a deduction which leads to an experiment or observation that may falsify or support the hypothesis. Those hypotheses which are supported are retained as tentatively true. This discussion needs strengthening.

p. 27: In general, when a major hypothesis has survived testing, it is called a theory.

This is a weak definition. A theory is a grand unifying explanation of a large body of observations and data about a major phenomenon in the natural world. Examples include cell theory, atomic theory, germ theory of disease and evolutionary theory.

p. 82: This 'living stuff' of cells, the thick, jellylike substance which makes up most of each cell, is protoplasm.

This term is archaic and seldom used today since we know so much more about cell architecture.

p. 144: In some cases, humans develop diseases which are genetic in origin. Genetic diseases are not really rare; many people are affected by genetic diseases.

A prefered term is genetic disorder, not disease.

p. 179: The change in organisms over a period of time is called evolution.

This definition is weak since it omits reference to descent with modification: species are related by evolutionary change. Evolution is a sophisticated concept difficult to define. One possibility is, "change over time of one species of living thing into other and different species; descent with modification."

> p.179: The theory of evolution is the most widely accepted scientific explanation of the origin of life and changes in living things. You may wish to investigate other theories. (This is a marginal note in blue ink.)

This statement is misleading. There are no other accepted scientific explanations for the presence of life as we know it; if there are, they should be included in this book. Any other explanations fall outside the definition of theory on page 27 and should not be so defined. The heart of evolutionary theory is its ability to explain past and present diversity, not the origin of life.

> p. 179: 10.1 Fossils: Formation and Dating....Then, as the sediments turn to rock over long periods of time, part of the organism is preserved.

This is wrong. The original part is gradually replaced by minerals in most cases. This concept is especially important because radioisotope dating methods cannot be applied directly to fossils which generally do not retain any original carbon. This section needs correcting.

> p. 181: Ages of older fossils can be estimated by studying surrounding rock samples for other radioactive elements such as uranium and potassium.

The technique is poorly stated although the basic concept is correct. Measurements on igneous intrusions provide maximum dates for surrounding sedimentary and metamorphosed rock.

> p. 182: In order to survive in a changing environment organisms must adapt (marginal note).

This is sloppy writing which imparts a Lamarckian view. Populations or species adapt, not organisms.

> pp. 182-183: 10-2 Fossil Record: Interpretation (entire section).

The publisher discusses only extinction whereas appearance of new life forms is an equally important aspect of the fossil record. A concluding sentence, "Many fossils linking one organism to another have not been discovered," denies the rich body of evidence for evolutionary lineages. This section is distorted.

> p. 184: At one time in the past perhaps some ancestor of humans may have had an appendix with some major functions.

p. 185: It is thought that humans and pigs are related (emphasis added).

The conclusions of scientists are based on evidence. They are not opinions or speculations as these passages imply.

pp. 188-193: Evolution: Some Explanations (entire section).

The discussion of Lamarck and Darwin's ideas is generally good with only one serious problem: a misguided attempt to explain the giraffe's long neck through natural selection. The hypothesis proposed is unscientific because it cannot be tested. In addition, giraffes are browsers, not grazers, therefore a grass shortage was probably not a factor. This example, drawn from the history of biology, oversimplifies a complex problem and should be included only if it is placed in its historical context.

pp. 193-195: Origin of Life (entire section).

This discussion of the Oparin hypothesis is too short. Why did he assume an atmosphere of methane, ammonia and water? What evidence is there that simple organic compounds can form complex molecules? What kind of membrane is being considered for the proposed primitive "cell"? This section needs some expansion to be effective.

p. 201: A population is a group of organisms which naturally interbreed.

This is a good definition of a species and should be so identified. A population is a subset of a species.

p. 213: Humans are unique organisms (marginal note in blue ink).

Why did the publisher single out humans? By definition every organism--or species--is unique.

p. 213: Humans are indeed unique, but because they are organisms, many scientists believe that humans have an evolutionary history.

Can the publisher name one respected anthropologist who has not concluded that humans have an evolutionary history? The evidence is overwhelming and the publisher should eliminate such weak phrasing introduced only to satisfy parochial critics.

pp. 213-219: Human Origins (entire section).

Despite a hesitant introduction (see above) this section on human evolution is one of the best among the textbooks reviewed in this commentary.

p. 225: Each organism is given a two-word Latin name. The first word, often a noun, is the genus to which an organism belongs. Its first letter is a capital. The second word, an adjective, represents the species.

This is incorrect. The second word is the specific epithet or name. The two words taken together constitute the species name; hence binomial nomenclature.

pp. 226-227: 12.3 Bases for Classification (entire section).

The publisher might raise one important question: "Why can we classify organisms into such neat, nested categories?" Taxonomy provides evidence to support a deduction from the hypothesis of evolution: "If the members of a taxonomic unit such as the phylum Chordata share a common ancestry, that should be reflected in their structure. Since chordates are structurally similar, the hypothesis of evolution is supported." Similarly, comparative DNA and protein studies confirm a hypothesis of evolution.

pp. 710-712: Appendix C Biology-Related Careers.

This presentation is weak, overemphasizing medical and health sciences careers. What about geneticists, genetic counselors, agronomists, ecologists, oceanographers and so forth?

pp. 715-744: Glossary.

Comparative anatomy: studies of similar structures among organisms. One may also study dissimilar structures.

Consumer: living things which obtains food from other organisms. Correct subject and verb agreement.

Evolution: process of change with time during successive generations among living things.

This definition does not make sense. Add the concept of descent with modification and note that as a result of evolution new species form.

Hypothesis: an idea or statement which explains the relationship among observed facts.

This is a poor definition. Include the concept of tentativeness.

Larva: developing organism leading an independent existence.

Independent of what? Parasitic larvae are not independent.

Theory: fundamental hypothesis which has survived the test of time.

This is unscientific: What is the "test of time"? A theory is a grand synthesis of information (data and observations) about a major phenomenon of the natural world.

"Translocation: transport of food in a v_____cular plant..."

The letters "as" are missing.

Title: Modern Biology (1985)
Authors: James Otto and Albert Towle
Publisher: Holt, Rinehart and Winston, CBS, Inc., 383 Madison Avenue, New York, New York 10017

General Comments

No less than 45% of Modern Biology is devoted to an earth-life review based upon the five-kingdom system. The book opens with a review of cells and energy transfer (15%) and then moves directly into a unit on heredity (13%) which concludes with chapters on Organic Variations (a euphemism for evolution) and taxonomy. Four units on physiology follow (45%), leading to an extensive unit on Human Biology (17%) which opens with a chapter on Human History (another euphemism for evolution). The book concludes with a final unit on Ecological Relationships (10%).

The nature of a scientific theory is not properly explained at any point in this book. A theory is much more than a hypothesis supported by evidence. It is a grand, unifying explanation of data and observation about a major phenomenon of the natural world. The publisher has also couched scientific conclusions in terms that make them appear to be mere opinions but only in the area of evolutionary theory. Conclusions elsewhere are stated dogmatically, giving them an often unwarranted aura of certainty. Such differential treatment of scientific knowledge can be attributed directly to the now-rescinded Texas anti-evolution rule.

Evolutionary theory appears in many places in this textbook and evolutionary relationships within major taxonomic groups are reviewed, albeit briefly and without the diagrams used in previous editions. Geological history is sketchy and discussion of radioactive dating methods is out of place in chapter 39 (instead of 14).

The publisher has subtly distorted or slighted evidence supporting evolutionary theory. Evidence that is presented is good science but has holes, many quickly apparent to the informed reader. This is undoubtedly a response to parochial pressure but has the effect of tearing the fabric of scientific knowledge.

Overall, the textbook presents a reasonable overview of biology with a heavy emphasis on classification and comparative anatomy. In this respect it is a traditional textbook. The publisher has emphasized vocabulary and factual learning in the chapter questions and teachers edition.

Specific Comments

p. 7: The steps followed in the scientific method are:
° Define the problem. You can't solve a problem unless you see one exists.

Having just stated in a preceding paragraph that "scientific investigation is used to answer questions," the emphasis here is shifted back to the old incomplete idea that science solves problems.

p. 8: Form a hypothesis. After collecting information and making observations, the scientist forms a working explanation or trial answer to the problem.

The next essential step is omitted: a deduction (prediction) is made from the hypothesis which is tested by experiment or observation. If the deduction is falsified, the hypothesis is discarded; if not, it is retained as tentatively true. In the text example tracing how the cause of Legionnaires disease was identified, scientists first hypothesized the disease was transmitted person to person, then by food, then by animals. In each case a deduction from the hypothesis was tested by observation which failed to support it. The publisher should revise this section to show science advances by disproving (falsifying) a hypothesis.

p. 9: If other experiments continue to support the hypothesis, it may become a theory....A theory is a hypothesis that is supported by experimental evidence over a long period of time.

This is an inaccurate definition of a theory. A scientific theory represents a grand synthesis of information about some aspect of the natural world. Time has little to do with its verification. The theory's ability to withstand repeated tests of deductions stemming from it is the critical issue. Establishing the cause of Legionnaire's disease did not create a new theory; existing cell theory was merely enlarged to include the new information.

pp. 77-78: "5.7 Endocytosis and Exocytosis."

This section is an example of the vocabulary overkill characterizing this textbook: endocytosis, phagocytosis, pinocytosis and exocytosis are all found in two paragraphs. A check of index citations for these words indicates that only phagocytosis is used extensively. Why are the other items introduced at all if they are not used?

p. 178: Scientists believe that the history of the earth began about 4.5 billion years ago.

Scientists don't believe. They reach conclusions based on evidence (pages 7-10, "a scientific method"). The evidence should be cited.

pp. 179-181: 13.1 The Beginning of Life (entire section).
It is estimated that life first appeared on earth some 3.5 billions of years ago....Through millions of years, more molecules were added and the soup became concentrated....Eventually, according to Oparin's theory, these molecules formed the first living cells....The first to test the theory was Stanley Miller in 1953.

First, evidence for the appearance of life 3.5 million years ago should be given. Second, the "soup" probably became concentrated only in tidal pools where evaporation is an important factor. Third, there are several intermediate steps between complex organic molecules and living cells which have been omitted in

this version. The concept is usually referred to as Oparin's hypothesis or the heterotroph hypothesis rather than Oparin's theory. Finally, Miller tested a deduction from Oparin's hypothesis and demonstrated only that complex molecules could form under the hypothesized conditions.

> p. 183: Scientists can determine the age of fossils by measuring the amount of radioactive elements such as carbon-14 in the fossils. A similar process using other radioactive elements can be used to date rocks.

But most fossils are rocks. Carbon-14 only works for fossilized organic matter less than 50,000 years old. Considering its importance, this is an inadequate discussion of dating methods.

> p. 185: "13.15 Eukaryotic Cells" (entire section).

The publisher has commendably included discussion of hypotheses on the origin of eukaryotic cells, an important topic.

> pp. 186-188: "13.7 Evidence of Evolution" (entire section).

Evidence for evolution is clearly separated from mechanisms of evolution, although the presentation is extremely brief. For example, the relationship between comparative protein and DNA studies and phylogeny is not mentioned here, although it is elsewhere. Also missing is evidence for evolution based upon organisms' geographic distribution.

> p. 189: Darwin's theory may be summarized by the following four points. 1. Individuals vary genetically.

This is not Darwinian. He never used the term "genetic" since he was unaware of Mendel's work. Individuals simply vary and the variation is inherited.

> p. 191: 13.11 Random Mating. This means that there is no preference shown for any particular phenotype when mating. For example, an individual that is (Aa) is not preferred over an (aa) individual.

Random mating is not always the case in nature--and nonrandom mating can drive evolution. This is evident in mate selection. Figure 13.9 on the opposite page shows male rams fighting during a rutting season; the largest and heaviest will get to mate. This section should be enlarged to show why failure to meet this stricture of the Hardy-Weinberg law leads to evolutionary change.

> p. 194: A species is a group of genetically similar organisms that can mate to produce fertile offspring.

This definition should be modified to "that mate naturally." Lions and tigers can mate to produce fertile offspring but they don't in nature. Barriers to breeding can be behavioral as well as genetic and physiological.

p. 203: In binomial nomenclature the first word names the genus in which the organism belongs. The second word names the species.

This is wrong. The first word does name the genus but the second word is called the specific epithet or name. The species name consists of the two words together; hence binomial nomenclature.

p. 204: Taxonomy began to be based on a family tree or evolutionary history rather than appearance alone. Fortunately, many of the old groups did not have to be changed too much.

One of the most convincing arguments for evolution is the nested categories of taxonomy. The original classifications, set up on the basis of structural similarities alone, have been repeatedly confirmed by comparative DNA and comparative protein studies. It is not fortunate that the taxonomic groups did not have to be changed; it is a deduction from the theory of evolution confirmed by observation!

p. 205-206: Genetic similarity is one of the strongest pieces of evidence of relationships among organisms.

Why doesn't the publisher give a specific example of genetic similarity? There seems little point in introducing another concept unless it is used.

p. 287: 20.4 Characteristics of Ascomycetes; 20.5 Pryenomycetes; and 20.6 Discomycetes.

In addition to these names, we also find the following new terms, all on one page: ascospores, ostiole, asci, apothecia and perithecia. This is vocabulary overkill.

p. 309: The angiosperms, or flowering plants may have evolved from a primitive gymnosperm.

p. 315: Angiosperms are thought to have developed from a primitive gymnosperm shrub about 130 million years ago...

p. 469: The earliest vertebrates are thought to have been aquatic animals that swam with a side-to-side wave-like motion.

p. 476: It is thought that fishes evolved from simple, primitive chordates, which in turn evolved from nonchordate marine organisms.

p.477: The jawless fishes are thought to be the most primitive and oldest vertebrates.

p. 532: "Like the dinosaurs, birds are thought to have evolved from the ancient lizard-like reptiles called thecodants... (emphasis added).

Scientists reach conclusions based on hypotheses supported by evidence. The use of terms like "may have," "thought" and "believed" have the effect of converting scientific conclusions into mere opinions. Such language should be

edited out whenever it occurs as the practice confuses students about the validity of science. The publisher seems to use this phrasing only when discussing evolutionary relationships.

> p. 433: 4. Name the appendages on the head of the crayfish. 5. Name the appendages on the thorax of the crayfish. 6. Name the appendages on the abdomen of the crayfish.

Isn't it time to eliminate such archaic naming of appendages? The original purpose of the exercise--to demonstrate serial homology--has been lost.

> p. 532: 37.1 Fossil Evidence. The earliest birds are represented by fossils....Many of Archaeopteryx's characteristics were similar to those of the flying reptiles.

What characteristics and which flying reptiles? Archaeopteryx was very different from Pterodactyls which resembled bats, having a membrane-like wing and a greatly enlarged fourth digit. How did Archaeoopteryx resemble other dinosaurs? This section does a very poor job of discussing an important transitional organism.

> pp. 550-551: 38.1 Evolution of the Horse (entire section).

What happened to the diagram of horse lineage that was in earlier editions of Modern Biology? The present illustrations are unsatisfactory.

> p. 576: 39.2 Characteristics of Humans (entire section).

This section dwells on the differences between great apes and humans. What about the more important similarities, especially protein structure and DNA sequences? Humans and apes are more closely related than are foxes and dogs, yet none of this modern evidence is mentioned.

> p. 578: Fossil skeletons of early humans are not common, and the skeletons are not complete. In fact, only small pieces are usually found.

But in the aggregate our collection of humanoid fossils is quite good and growing yearly. This is amply demonstrated in the "Ancestors" exhibition at the American Museum of Natural History.

> p. 578: 39.4 Dating Fossils. (entire section).

This is a reasonably good discussion of fossil dating methods but it belongs in chapter 14 on evolution.

> p. 580: What would you find if you could trace the history of primates back 10 million years? You might find that both modern humans and modern apes have evolved from some early primate.

Such hesitant phrasing is unwarranted in the face of the overwhelming evidence of relatedness. It represents capitulation to parochial pressures.

pp. 580-582: 39.5 Humanoid Fossils (entire section).

This review of human evolutionary lineage omits at least as much as it includes. Where is "Lucy," known to every school child? Where is Australopithecus afarensis? And Homo habilis? Where is a diagram showing hypothesized relationships among these fossil forms?

p. 582: 39.7 Changes in brain sizes and skull shapes (illustration).

This illustration has a modern chimpanzee skull at the top followed by Australopithecus africanus, Homo erectus and Homo sapiens in that order, leaving the casual viewer with the impression that "humans evolved from apes." The chimpanzee skull should be placed at the bottom next to its modern contemporary, Homo sapiens.

p. 587: 40.3 The human skeleton can be divided into the axial skeleton (pink) and the appendicular skeleton (blue).

The blue color does not cover the appendicular skeleton. The clavicle is the collar bone not the shoulder bone.

p. 710: The tundra is a large area the encircles the Arctic Ocean.

The tundra association is not limited to this region, however, and may be found on high mountains the world over.

p. 721: The continent of Antarctica is at the South Pole.

It is better to say the South Pole is on the Antarctic continent.

p. 787-807: Glossary.

Evolution: the process in which all organisms have developed from older forms of life.

This is a strange and inaccurate definition which omits reference to biological change through time, the essence of evolution as well as speciation.

Foot: the large, muscular organ that mollusks use for locomotion. This limited definition applies only to mollusks.

Theory: a hypothesis that is supported by experimental evidence over a long period of time.

This is inaccurate. A theory is a grand unifying explanation of a large body of data and observations of the natural world. Examples include cell theory, germ theory of disease and evolutionary theory. Time has little to do with a theory's validity.

Title: Prentice-Hall Biology (1985)
Authors: Sandra Gottfried, Gerry Madrazo, Jr., LaMoine Motz, Joseph Olenchalk, Dorothea Sinclair and Gerald Skoog
Publisher: Prentice-Hall, Inc., Englewood Cliffs, New Jersey 07632

General Comments

This book is essentially a review of plants and animals (43%) plus human physiology (19%). Modern concepts are introduced at several points but are given brief treatment or are relegated to end-of-chapter perspectives. The appendix contains a list of Nobel Prize winners in physiology or medicine plus biology-related winners in chemistry and physics probably introduced in response to a recent Texas Board of Education requirement. Very few of these scientists' achievements are covered in this text. This is remarkable since the book carries a 1985 copyright date and is presumably a modern biology review.

The scientific method introduced in an early chapter is outdated and does not accurately present the hypothetico-deductive process. A theory, for example, is presented as a verified hypothesis rather than as an explanation of a major natural phenomenon. This basic misunderstanding of scientific method and the nature of scientific knowledge is evident throughout the text where the conclusions of scientists are frequently presented as opinions or beliefs.

Taxonomy is presented as an isolated branch of science bearing little relationship to our understanding of life history. The significance of nested categories, powerful evidence for evolution, is not at all developed. The five-kingdoms approach is discussed but not its significance as taxonomic levels representing major approaches to solving the problems of living. In the end the outdated three-kingdom system is used, a minus.

The single chapter on evolution does attempt to separate evidence and mechanisms with some success. Fossil evidence is reasonably well presented except for omitting evidence for the age of the earth and geological periods older than 50,000 years. There is a good geological time scale. Classical evidence for evolution is reviewed in a cursory fashion although modern biochemical evidence is barely covered with no discussion of comparative DNA studies. There is no consideration of how life might have originated on earth, although Miller's work is briefly reviewed in the chapter on chemistry.

Darwin's hypothesis of natural selection is briefly but accurately discussed and accompanied by the usual story of giraffes evolving longer necks in response to hypothesized but untestable (therefore unscientific) selection pressures. The deductions from Darwin's hypothesis and subsequent tests of his hypothesis are not provided, a serious omission.

The unnecessary and indefinate concepts of "microevolution" and "macroevolution" are used to distinguish between mere adaptation and speciation, whereas evolutionary biologists view the process as continuous with only the rate of evolutionary change in dispute. The use of these terms gives the chapter an irritating bias toward creationism which uses the terms to make it seem evolution of major groups has not been "proved."

A short chapter on human evolution identified as "human history" emphasizes differences between humans and primates and virtually ignores similarities. The Biological History of Human Beings (humans do not "evolve" in this textbook) does present a decent review of important fossils in the human lineage, although the summary diagram is difficult to interpret. The consequences of evolution for human welfare are virtually ignored in an otherwise interesting section on plant and animal breeding.

The textbook has several instances of distorting science in response to parochial pressure. One example has already been noted. Others include omitting evidence for the age of the earth and geological eras, and the glossary definition of evolution as "change over a period of time," which omits any reference to descent with modification, the heart of Darwin's concept.

Specific Comments

p. 19: As more and more data are collected that support a hypothesis, the hypothesis becomes a theory.

This is a weak definition of a theory which is repeated in the glossary. An adequate definition should embody the concept that a theory has broad explanatory power covering a range of observations. Scientific theories are synthesizing ideas not easily derived, which represent some of the peaks of human intellectual achievement. Darwin's theory of evolution ranks with Einstein's theory of relativity and Newton's theory of planetary motion.

p. 25 and other chapters: Suggested Readings.

There are no publication dates, making research difficult.

p. 44: The scientific name of an organism consisted of two Latin words. The first word referred to a larger category of organisms called a genus. The second word referred to a smaller category called a species.

This section on binomial nomenclature is in error and should be rewritten. The second word, written in lower case letters, is not the species name but the specific epithet or name (see Webster's New Collegiate Dictionary). An essential part of the system is the type description which is published so that all may be informed of what the species characteristics are.

p. 45: Modern Taxonomy (entire section).

An introduction to taxonomy is incomplete without reference to the essential question of why we are able to classify organisms into such neat, nested categories of relatedness.

pp. 47-51: Classification Systems (entire section).

The three-kingdom approach selected by the publisher is inadequate and out dated.

p. 90: Prokaryotes and Eukaryotes (entire section).

Having introduced these concepts, it is important to describe modern hypotheses which relate these seemingly disparate forms. Margulis, for example, has proposed that some eukaryote organelles are derived from prokaryote cells that once were symbiotes in an early cell. Thus, mitochondria retain their own bacteria-like DNA as do several other organelles. One of the great ideas of this century is that all life on this planet is related and has a common origin; this conclusion from evidence should be mentioned.

> p. 199: The process by which an organism becomes better suited to a change in environment is called "adaptation." Each of the nearly 2 million known species of living things on the earth has special adaptations, or helpful variations that make them better suited to their environment. Organisms may have adaptations in body structure or function, coloration, or behavior. For example, horses have flat teeth and powerful jaw muscles for chewing and grinding grasses. Tigers have sharp, pointed teeth that are used for tearing flesh. The large tusks of walruses and elephants are used for defense.

This is a confusing paragraph. To begin with, it should read either species or population, not organism, in the first sentence. Second, the discussion centers on adjustments to either a changing environment or new opportunities (as in adaptive radiation). Yet, the examples provided (horse, tiger and walrus teeth) are major multigenic characteristics at the taxonomic level of order. This paragraph should be rewritten.

> p. 199: Take a look at your classmates. You will notice many similarities because all of you belong to the same "species." A species is a group of organisms that interbreed.

This is a weak definition of a species. A better one is, "an evolved and evolving population of naturally interbreeding plants or animals." Certainly the concept of "naturally interbreeding" should be added to exclude lions and tigers which interbreed in zoos but not nature.

> p. 200: Evidence of Evolution.
>
> ...The theory that describes the changes in living things and links them to changes in the environment is called evolution. Evolution is change over a period of time.

The theory of evolution has two aspects: evidence for evolution and mechanisms for evolutionary change. Although the following discussion recognizes this important separation, these sentences do not. There is also an unwarranted stress on environmental change but other factors are known to operate such as genetic drift and the opening of new opportunities after a mass extinction. Finally, evolution's definition should contain the concept of descent with modification linked to a population whose members share the new adaptation.

> p. 202: Dating Fossils: Fossils are useful only if scientists can tell how long ago the organisms lived.

This is wrong. Engineers and geologists used fossils for 200 years before anyone learned how to date them accurately. Change this to suggest fossils are more useful if their absolute ages can be determined.

p. 205: ...Scientists think that the arrangement of the bones in these animals was inherited from a common ancestor.

According to some biologists, organs such as the human appendix or the remains of hind limbs on whales provide evidence of evolution (emphasis added).

Scientists reach conclusions based on evidence. Publishers should avoid using phrasing that suggests scientists merely have opinions or good guesses which can be believed or not. Such language biases discussion toward creationism, a belief system based on religious faith rather than scientific evidence.

p. 206: Biochemical Evidence (entire section).

In addition to comparative protein studies, mention should be made of comparative DNA studies. The publisher should relate these interesting lines of investigation to taxonomic categories. For example, human proteins are more closely related to those of primates than dog proteins are related to those of foxes. A diagram illustrating comparative DNA and protein studies would help students understand this modern technique.

p. 208: Darwin's Theory accompanying Highlight (entire section).

This statement of Darwin's hypothesis of natural selection as the mechanism of evolution is reasonably well done. The only problem is the giraffe illustration on page 209 which proposes an unscientific hypothesis that cannot be tested. It is armchair hypothesizing.

p. 210: Microevolution and Macroevolution (entire section).
Highlight Microevolution refers to a small, gradual change in a species. Macroevolution refers to a large and sudden change that produces a new species.

Use of these terms, microevolution and macroevolution, suggest different evolutionary processes are operating at different taxonomic levels. There is is little evidence to support such a notion. Their appearance in an introductory textbook reflects attempts to appease creationist critics. They accept microevolution as adaptation based on genetic variability of originally created kinds but strenuously deny the possibility of macroevolution or speciation. (See the critique of the Gabler's comments in chapter 6.) In addition, the definitions of these terms vary depending upon the source, even in scientific literature. This section should be deleted or edited.

p. 211: There are cases in which random changes in gene frequency occur. In such cases of "genetic drift" the Hardy-Weinberg law may not apply. Despite these cases, the law continues to be useful because it enables geneticists to determine the processes involved in evolutionary change.

The concept of genetic drift is important to understanding how speciation occurs, but simply introducing the term is not the same as properly developing it. If the publisher wishes to leave the term in the text, it should be given more extensive development.

p. 211: All of the genes of a given population are called a "gene pool." A population is all members of a species living in a given area at the same time. Variations in the gene pool cause changes in the species. If there are no changes in the gene pool, there are no changes in the species.

"Variations in the gene pool cause changes in the species" is a simplistic view of the modern synthesis of evolutionary theory. It is also at odds with the preceding sentence which defines the gene pool as a limited population, a subset of the species. The gene pool is also limited to the genes of sexually mature population members. This paragraph should be edited to agree with good science and logic.

p. 221: The order "Primates" contains more than 200 living species ranging from primitive insect-eating tree shrews to human beings, the most advanced member of the order. Scientists think that the primates separated into different lines of development...

The publisher has used the term "think" to describe conclusions of scientists based on evidence, thus leading the student to believe scientists merely have opinions or "good guesses."

p. 233: Perspectives in Biology: Sudden or Gradual Changes in Living Things (entire section).

This discussion of punctuated equilibrium is inaccurate, incomplete and should be reviewed by one of its proponents such as Stephen Jay Gould or Niles Eldredge. Their basic view is that some evolution consists of rapid development of a species followed by a long period of stasis as shown by the fossil record. "Rapid" in their view is on the order of 50,000 to 100,000 years, hardly a "sudden" appearance. Finally, the phrase "sudden evolutionary change" is a creationist term and has no place in this discussion.

p. 517: Scientists think that the cotylosaurs gave rise to several major groups of specialized reptiles. Today's lizards, snakes and tuataras are thought to be direct descendants of cotylosaurs. Mammal-like reptiles called therapsids also may have descended from the cotylosaurs. Now extinct, the therapsids evolved into true mammals. The thecodonts probably sprang from the cotylosaur line, too. Now almost all extinct, the thecodonts included the "dinosaurs," the pterosaurs or flying reptiles and modern crocodiles.

This is a very confusing paragraph which offers the student several hard-to-pronounce names without forming a coherent pattern. It represents extremely poor pedagogy and should be rewritten.

p. 537: The fossil remains of birds are rare because the bones of birds are very fragile. Scientists have found, however, well-preserved fossils of two birdlike dinosaurs. One flying reptile, called the dawn lizard, had flaps of skin attached to its long ribs. These flaps were useful in flying. The "pterodactyl," another flying reptile, had wings made of skin stretched over long, fingerlike bones.

To our knowledge, the dawn lizard and the pterodactyl are not examples of birdlike dinosaurs in the sense of anatomic homology but appear to be simply cases of convergent evolution. Bats are no more birdlike than are flying squirrels. The subsequent discussion of Anchaeopteryx helps, but even here anatomic relationships are not developed.

p. 567: Primata. Tree dwelling mammals.

This characteristic is not diagnostic. Gorillas and humans are not tree dwellers.

p. 567: Perissodactyla. Odd-toed hoofed mammals. Zebra. Horse. Tapin.

Why include this order and not the Artiodactyla--the even-toed hoofed animals like the camel and ox?

pp. 800-817: Glossary.

Evolution change over a period of time.
This definition is incomplete: add descent with modification.

Theory: proposed explanation that is supported by considerable experimentation.
This definition is incomplete.

Title: Experiences In Biology (1985)
Authors: Penelope Bauer, Michael Magnoli, Armand Alvarez, Dorothy Chang-Van Horn and Delilah Gomes
Publisher: Laidlaw Brothers, Publishers, Thatcher and Madison, River Forest, Illinois 60305

General Comments

This textbook's major emphasis is on cataloging life forms (38%) with additional units on energy paths in living systems (15%), reproduction, heredity and evolution (15%), human physiology (15%) and ecology (7%). This content distribution appears to be a compromise between a traditional emphasis on classification and description of living things and a recognition that modern biology requires understanding of certain processes such as energy flow.

The presentation of the scientific method fails to set forth the chief tool of modern science: the hypothetico-deductive process. The text, for example, calls hypothesis "a trial solution used to explain observable facts" but fails to explain that predictions may be deduced from the hypothesis which can be tested by experiment or observation. It is this testability of an explanation that makes it scientific. The text also defines a theory as little more than a hypothesis that has not been disproved, thereby failing to convey the intellectual power of a theory as an explanation of a major natural phenomenon. Examples include the cell theory and the germ theory of disease.

The publisher consistently presents scientific conclusions which are based upon evidence as "beliefs" or "opinions" which can be accepted or not at the student's whim. One passage discussing the possible origin of life on earth (the Oparin hypothesis) illustrates this tendency to view scientific knowledge as merely a collection of ephemeral ideas: "One thing you should keep in mind is that these explanations are only ideas. However, these ideas may help you to know how some people think life began."

Aspects of evolutionary theory are introduced at several points but the publisher has failed to build a body of evidence and concepts which lead to a thorough discussion of evolutionary theory in the single chapter devoted to this topic. Natural selection, for example, is introduced in chapter II but its presentation is naive and inaccurate, more reminiscent of Lysenko than Darwin. The possible origin of life is reviewed reasonably well in chapter IV but the topic is not developed further when procaryotes are discussed or when DNA is presented as the universal stuff of heredity. During the extensive discussion of classification, many opportunities to discuss evolutionary relationships--and make sense of the bewildering panopoly of life forms--are simply ignored.

The development of fossil evidence for evolutionary change is inadequate. For example, the text lacks a decent discussion of what constitutes a fossil and how fossils are formed. A true geological time scale is absent and the half-page illustration of four major geological eras has little value in conveying the concept of geological time and the panorama of earth-life. Evidence for the age of the earth and geological features based upon radioisotope decay is not presented at all. Classic evidence for evolution derived from comparative

anatomy and comparative embryology is briefly reviewed but there is no mention of modern evidence derived from comparative protein and DNA studies which independently confirm taxonomic relationships. Geographic distribution, crucial to Darwin's thinking, is not mentioned.

The chapter on evolution appears to have been hastily written for insertion into an existing book without regard for logical and progressive development of major ideas. The word "evolution" is defined as "change from a lower to a higher form," a definition both ignoring the concept of descent with modification and introducing a directionality modern synthetic evolutionary theory does not require. The treatment of Darwin's ideas of evolution and natural selection as its explanatory mechanism is unbelievably poor and should be totally rewritten. The illustration purporting to show evolution in starfish is a travesty of Darwin's concept of natural selection as the guiding force in evolution.

Human evolution is discussed under the chapter title, "What is a Human?" However, the chapter fails to cover evidence for human evolution in a realistic manner, dwelling instead on differences between humans and other animal kingdom members. Nothing is mentioned about the overwhelming similarities between humans and primates including anatomy, brain development, protein structure and DNA sequences. Even the word "evolution" is replaced with the euphemism "Some Human History."

This book is characterized by too many small errors which cumulatively denote careless construction and mislead the student.

Specific Comments

p. 13: Hypothesis: a trial solution used to explain observable facts or data; also the basis for predicting new facts.

Theory: an explanation that seems to fit the facts and data; a hypothesis that has not been disproved although attempts have been made to disprove it.

There is no distinction made between hypothesis and theory in these definitions. Neither definition stresses verification through observation, the hallmark of the scientific method.

p. 14: 12. How does a scientist solve a problem? (entire discussion).

This discussion of the scientific method is a reasonable start but fails to set forth the chief tool of science: the hypothetico-deductive method. The issue is not solving a problem but answering questions. This point is made in the quotation by Einstein on page 14 but is not followed in the text. An alternative paragraph might read:

> In general, however, they approach a problem by first asking a question about some observations made about nature. They may make additional observations to help them formulate the question. Then they develop one or even several hypotheses which explain the observations. A hypothesis is a tentative explanation leading to a deduction that can

be tested by experiment. It is not a useful hypothesis unless it can be tested by observation. The experiment should be designed to eliminate (not prove) one or more of the alternate hypotheses.

p. 31: Suppose some members are somewhat more resistant to cold than others of that species are. During a cold spring, many individuals might die. But those that are cold-resistant would live. Suppose, too, that the climate gradually changes, with each spring being a little colder than the spring before. Then, being able to resist the cold would be helpful. Organisms able to resist the cold would live and pass their traits on to their offspring. As time passes, more and more individuals of that species would be resistant to cold.

This hypothetical example is naive and inaccurate. It reflects the simplistic reasoning of Lysenko and Lamarck. In fact, characteristics like cold resistance in plants are controlled by multiple genes which are not as susceptible to selection as described. A better example should be selected, such as insect resistance to DDT.

p. 50: This kind of naming--known as binomial nomenclature--is still used today. The first part of the two-word name is the genus name and the second part is the species name.

This is incorrect. The second name is properly called the specific epithet or name. The two names together constitute the species name; hence binomial nomenclature.

p. 61: Chapter 4. The Beginning of Life (second paragraph).
Do any of these ideas seem possible to you? You'll have a chance to learn more about some of them as you study this chapter. One thing you should keep in mind is that these explanations are only ideas. However, these ideas may help you to know how some people think life began.

All scientific theories (explanations) are only ideas. Why single out explanations of how life began for special emphasis? Such cautious phrasing is introduced in response to parochial pressure. It is far more important to tell students that science deals only with explanations that can be tested by observation and that the most we can say about the beginning of life at this point in history is that it might have happened in this way. In other words, the Oparin hypothesis has not been falsified by experiments: it works as an explanation.

p. 73: However, Oparin's hypothesis is now widely known as a theory or hypothesis that has been tested.

This is a false definition of a theory. A better definition is that a theory is an explanation of broad scope and predictive power which has survived extensive and repeated attempts to falsify it based upon deductions derived from the theory. Evolution is such a theory; the Oparin hypothesis is not.

p. 291: 16-5 Feathered reptiles? (entire section).

The discussion of Archaeopteryx is fraught with difficulties. First, the fossil photo is on page 475 without a cross reference. Second, the statements, "Reptiles do not have feathers. Birds are the only animals that do," applies only to modern reptiles and birds. But if modern birds evolved from ancient reptiles, this is exactly the combination one would expect, a true intermediate form. Third, there is no reason to imply that Archaeopteryx was cold-blooded; in fact, there is good evidence that several dinosaurs were warm-blooded. Fourth, the value of Archaeopteryx as a link in the evolutionary chain between dinosaurs and birds is not discussed in sufficient detail to be meaningful.

p. 315: Although the earliest mammals are believed to have lived on land...

Change this to read, "From fossil evidence scientists have concluded the earliest mammals lived on land..." The publisher repeatedly uses conditional modifiers--such as "believed"--when referring to evolutionary relationships, but not when referring to other relationships.

p. 347: What is the Oldest Living Thing? (sidebar).

This discussion is incomplete. The figure of 4,900 years for the age of a bristle cone pine is derived from tree ring studies. By overlapping ring studies with yet older specimens from dead trees, the age of some specimens has been pushed back to at least 8,000 years. Such studies are used to confirm the accuracy of the carbon-14 dating method (never mentioned in this textbook). But concluding the discussion by asking, "Could some of these redwoods be older than 4,900 years?" simply panders to the creationist notion that the earth is only about 6,000 years old. Modern students deserve better treatment than this.

p. 466: More than two million kinds of living things are present on the earth. Each kind--from bacteria to elephants--is different from every other kind.

Even though succeeding sentences point out that living things are related, the use of the biblical and unscientific term "kinds" when species is meant panders to the creationist view and confuses students. Substitute the proper word--species--for kind.

p. 467: The theory is based on the belief that populations of living things evolve or change over long periods of time.

Use of the word "belief" to describe the conclusions of science is inaccurate. The theory is a conclusion based on accumulated evidence that species have evolved.

p. 467: The word evolution means "change from a lower form to a higher form."

This is not a scientifically acceptable definition. A better definition of evolution is, "descent with modification; the change of one species into other and different species." The directionality from lower to higher forms is not a

requirement of evolutionary change, and many examples exist of change from more complex to simpler forms which opened new environments for exploitation. The tapeworm comes to mind.

> p. 470: Figure 25-5. Darwin's theory of evolution by means of natural selection is illustrated with the starfish being used as an example. (1) A starfish produces millions of eggs. (2) Numerous starfish struggle as they compete for food. (3) Every starfish is different from every other starfish in certain ways. (4) The starfish that blend with the environment survive predation by crabs. (5) The surviving starfish pass their trait for coloration on to their offspring.

This caption is a gross misrepresentation of Darwin's theory of natural selection and is the sole discussion of his hypothesis in this chapter. Organisms tend to overproduce, yet populations tend to remain constant. Therefore, there must be a mass dying off at some point in their life cycle. Individuals of a species tend to vary and this variability is heritable. Some are better adapted to their environment than others and have a better chance of surviving. These are the individuals who tend to reproduce and pass their traits on to their offspring. What has competition for food to do with protective coloration as the illustration suggests?

> p. 471: Even though he did not have an understanding of genetics or DNA codes, Darwin suggested a mechanism for evolution that seems to agree with today's research in this field.

Such caution is totally unwarranted. Natural selection as a mechanism for evolution has been supported by over 100 years of intensive research. It was never more strongly supported than by recognition that DNA is the universal code of heredity, and that taxonomically close organisms have closer matching DNA than more distantly related organisms.

> p. 472: When interbreeding is no longer possible, new species have formed.

This reflects the inaccurate definition of a species given in the glossary: "a group of organisms that are alike and are able to interbreed to produce new organisms of the same kind." First, the definition should stress naturally interbreeding populations, for some species will interbreed in zoos or the laboratory such as lions and tigers or mallard and pin tail ducks. Second, the phrase, "to produce new organisms of the same kind," is redundant and serves only to introduce a nonscientific term, kind.

> p. 472-473: Sections 25-5, Microevolution; 25-6, Macroevolution; and 25-7, Megaevolution.

These terms artificially divide what appears to be a continuous process and imply that different processes are operating, a notion which lacks supporting evidence. They are variably defined even in the scientific literature.

p. 472: Like other kinds of evolution, macroevolution depends on variations and on natural selection. But it also depends on isolation, or separation, of members of the same species. Members may be separated by barriers such as mountains, rivers or oceans. Such barriers help cause macroevolution.

First, as defined in this way, there is no difference between micro- and macroevolution and using these terms serves no scientific purpose. Speciation is meant and that term should be used. Second, barriers do not cause evolution. Different environments acting on separated populations cause evolution.

p. 474: Figure 25-9. This provides a diagramatic presentation of the four major geologic eras: Precambrian, Paleozoic, Mesozoic and Cenozoic.)

This figure has little value in conveying the concept of geological time and the panorama of earth-life. Scientific evidence for the ages is not developed in the text, a serious omission.

p. 474: Evolution and Continental Drift (sidebar). Scientists believe that the continents move as the plates that form the earth's crust move... (emphasis added).

Here is additional use of the word believe to describe scientific conclusions based upon evidence. The evidence for continental drift is not developed in the text, nor are the theory's implications for distribution of earth-life.

p. 474: Such changes cause plants and animals to adapt. Those that are able to adapt to the new climate survive. Those that cannot adapt become extinct.

Plants and animals do not adapt: populations adapt. The sentence is Lamarckian in its implications and should be changed to agree with modern evolutionary concepts. Extinction may also have multiple causes of which nonadaption is only one.

p. 475: Figure 25-10. A fossil of a bird called an archaeopteryx is pictured. What traits of reptiles do you see? What traits of birds do you see?

The illustration measures only 2 by 3 inches, making the questions frustrating for students since they cannot be answered. Archaeopteryx is an important fossil, with all the characteristics expected of an intermediate form between one line of dinosaurs and modern birds, but one would never know it from its treatment in this textbook. There is some discussion of the organism on page 291 but without cross reference, the students will miss the connection. In addition, Archaeopteryx should be written in italics with an initial capital as it is a genus name.

p. 476: 25-9 Gradualism and punctuated equilibrium. Today, not all scientists agree on how evolution through natural selection takes place. Two theories deal with this question.

This is inaccurate. Scientists readily agree on how evolution through natural selection takes place. The debate--an important part of the scientific process--is over the rate at which it takes place.

p. 477: Find Out by Doing. How does artificial selection affect certain traits?" (entire boxed paragraph).

Chickens' average egg production has increased but to suggest it is solely due to artificial selection is wrong. The illustration depicting mass produced chickens with automatic feeding, waste removal and egg recovery shows that controlled environments must play a role. Furthermore, there are antibiotics included as feed supplements that also increase egg production.

p. 480: Illustration caption. ...They are afraid that "mad scientists," such as the one in the movie scene shown, may use recombinant DNA research to create dangerous organisms...

The use of these illustrations and the caption "mad scientists" to illustrate a section on recombinant DNA research is irresponsible. We have enough difficulty with stereotypes in movies and fiction without having to contend with them in a textbook that claims to be presenting science. The topic is too important for such tricks, which only serve to foster an antiscience attitude among students. Finally, the discussion of gene-splicing is inadequate.

p. 486: Figure 26-1. In the illustration below, two views of a human pelvis and two views of a gorilla pelvis are shown. The way in which the pelvis is shaped determines whether or not a creature can stand and walk fully erect. How would you describe the differences between the human pelvis and the gorilla pelvis?

The question raised by the caption is impossible to answer from the illustration. The textbook should provide diagrams of articulated skeletons if students are to answer that question.

p. 490: 26-6 Looking for our ancestors. Where did people come from? This question has puzzled scientists for hundreds of years. Some think an answer can by found by studying fossils of people who lived a long time ago.

First, to say this question has puzzled scientists for hundreds of years is to fail to understand the history of science. Few scientists, if any, before Darwin's time ever doubted that humans were created. That is hardly hundreds of years. Second, studying fossils of people won't help. What we need to do is study the fossils of prehumans in order to understand our evolutionary history. Third, where else would we find evidence for human history except in fossils? Comparative biochemistry and comparative DNA studies are possibilities, but this textbook chooses to ignore such evidence.

pp. 643-656: Glossary.

Antenna: one of the long hair-like parts on an insect's head, which is used as a sense organ.

Organisms other than insects have antennae.

Evolution: the changes in living things over long periods of time.

This omits the concept of descent (relatedness) with modification.

Mandibles: the anterior jaws of insects.

Mandibles also occur in crabs, humans and so forth.

Swimmerets: the abdominal appendages that lobsters use to carry fertilized eggs.

Swimmerets are also found in crayfish and other arthropods.

Theory: an explanation that seems to fit the facts and data; a hypothesis that has not been disproved, although attempts have been made to disprove it.

A scientific theory represents a grand synthesis of information about some aspect of the natural world.

Ventral: referring to the undersurface or anterior surface of an animal.

Ventral does not mean anterior.

Advanced Biology

Three books have been reviewed. Of these, two are collegiate texts (Holt, Rinehart & Winston and Addison-Wesley) suitable for advanced placement programs. Only one (Prentice-Hall) was written for secondary students. Holt, Rinehart & Winston and Addison-Wesley both cover biology in the encyclopedic fashion favored by college instructors. Neither is particularly strong in covering the process of science. Both barely discuss gene splicing. Each is more than 900 pages long. The Holt, Rinehart & Winston book has better evolutionary coverage than does the Addison-Wesley text.

The Prentice-Hall book is in a different category. It is mainly concerned with the process of science. It is the only text to include computers, their operation and use in science. It also has a sectic on science, technology and society. Rather than repeat the content of Biology I it offers a nonrepetitive approach to scientific methodology and provides an alternative choice to "more of the same" at a higher vocabulary level.

94 BIOLOGY TEXTBOOKS

Title: Biological Science: Interaction of Experiments and Ideas, 4th edition (1983)
Author: Biological Sciences Curriculum Study
Publisher: Prentice-Hall, Englewood Cliffs, New Jersey 80027

This second-level biology textbook contains 440 pages of text (unusually short for a biology book) divided into 14 chapters. Part I, the Nature of Biological Science (27%) introduces the student to basic experimental methods beginning with the nature of science. Succeeding chapters introduce hypothesis formation, control of experimental variables, problems in measurement, basic statistical analysis and utilizing scientific literature. Part II, Experiments and Ideas in Biological Investigations (45%), encourages the student to carry out research projects in several major biological divisions: animal behavior, population dynamics, animal development and human genetics. Part III, Science, Technology and Society, teaches the student how to study an aquatic ecosystem, consider the multiple impacts of economic development on ecosystems and use computer programs to project the impact of changing one variable at a time in a program modeling a complex system.

Biological Science provides a sophisticated year-long course in science taught from the biological perspective. The authors assume students have basic biological background obtained from completing a good introductory biology course. They make no attempt to review previous work except to focus attention on particular topics. This approach sharply contrasts with the two other textbooks reviewed here for a secondary course. Both take the student through a complete spiral of biological knowledge, one level beyond the introductory course. For this reason some teachers will not find Biological Science suitable for a traditional advanced placement course.

The emphasis throughout this textbook is on scientific investigation. As the foreword notes, "It is by such investigation that biological knowledge is expanded by each generation of biologists. The path you will follow leads to the only reliable way science can grow." The student is taken through a graded series of laboratory investigations teaching the basic methods of biological research while introducing major intellectual problems in several biological areas. The concluding section seriously considers the role of science in modern society. Students completing this course will be exceptionally well prepared with skills in analysis, logic and creative thinking to undertake preparation for careers in science, medicine, the humanities, business or law. They will leave high school with a solid understanding of how science really works.

Biological Science is not without problems. It will not answer the demands of grade-conscious students who want to get a leg up on college work by completing a college-level biology course while still in high school. It requires a classroom laboratory equipped with a variety of supplies and simple but specialized equipment. It requires the support of a well-trained, enthusiastic teacher who will make the course "work." But the program's rewards are enormous, especially in an era when our educational, business and political leaders are setting a national goal of scientific and technological literacy for all high school graduates. Few books, and certainly no others in biology, do as much to achieve this goal as does Biological Science.

Title: Biology, 2nd Edition (1982)
Authors: Karen Arms and Pamel S. Camp
Publisher: Saunders College Publishing, CBS College Publishing, 383 Madison Avenue, New York, New York 10017 (Distributed by Holt, Rinehart & Winston Division of CBS)

This is a large textbook with 903 pages of text and 51 chapters. The Introduction (1%) considers the limits and methods of science and introduces evolutionary theory. Part I develops cell theory (12%) and the concepts of metabolic energy flow. Part II (11%) covers DNA, protein synthesis and genetics. Evolutionary theory in Part III (10%) is developed from population genetics and leads naturally into discussing the diversity of life using the preferred five-kingdom classification (Part IV, 19%). Part V, the book's largest section covers animal physiology from nutrients through reproduction to behavior. Plant biology (Part VI, 10%) is essentially a review of plant structure and function. The book ends with a unit on ecology (Part VII, 12%) concluding with a chapter on evolutionary ecology. As the authors note in their preface, "Deciding what to delete to make room for new material is seldom easy..." Nevertheless, traditional emphasis on classification (19%) and animal physiology (25%) is retained, perhaps at the expense of other topics, although chapters on biological energetics, evolution and reproduction and immunology have been added.

This textbook is sophisticated, encyclopedic and modern. It is suitable for use in an advanced placement course at the high school level provided the teacher is exceptionally well trained and experienced. The development of biology is logical and pedegogically sound with evolutionary theory used as a unifying concept. The hypothetico-deductive process introduced in chapter 1 as a method of science is used throughout the text. The authors raise important questions at key points which are then answered by citing research findings, an excellent teaching technique. Concepts introduced in early chapters, such as natural selection, are reinforced and amplified in later chapters. The findings of science are consistently presented as conclusions based upon evidence rather than beliefs.

Each chapter opens with a paragraph or two laying out the topic to be discussed in simple terms. In some cases, these introductions are misleading. For example, chapter 17 on speciation notes, "What we know about speciation comes mainly from circumstantial evidence: from the fossil record, from population genetics and from studies of closely related species." The reality is that all scientific evidence is circumstantial since it is recorded after the propagating event, whether the time delay is measured in microseconds or millions of years. Observations on fossils are no different in principle from observations on tagged atoms in metabolic pathways.

Chapter objectives are listed at the end as an aid to identifying critical concepts--and potential test topics. Self quiz items and questions for discussion are challenging and require more than merely regurgitating "facts." Vocabulary is not excessive and new terms are defined as they are introduced.

The topic of evolution introduced in chapter 1 (although with a poor example) is thoroughly developed in a five-chapter unit stressing population concepts. Although this presentation is thoroughly modern, it lacked discussion of evidence from comparative studies of DNA sequences and protein structures which so nicely verify established taxonomic relationships. This omission should be corrected. Vertebrate anatomy and evolutionary relationships are discussed in one chapter as part of the unit on diversity (of earth-life), a good strategy. Similarly, evolutionary aspects of reproduction are treated in another chapter integrated into the animal biology unit, and the evolutionary aspects of ecology are integrated into the final ecology unit. Discussion of human evolution is somewhat neglected, restricted to a three-page essay which falls short of presenting a coherent synopsis of human evolutionary lineage as presently understood.

The chapter on sexual reproduction and embryonic development deserves special note. It is written from the human perspective and necessarily includes diagrams of the human male and female reproductive systems. The chapter concludes with diagrams of a full-term uterus and fetus plus photographs of the human birth process. The information conveyed is directly related to biological concepts discussed in the text and is presented in a straightforward, accurate manner. High school seniors and juniors--the only people likely to take an advanced placement biology course--will have no difficulty handling the content of this chapter which is, after all, part of a college-level biology course. Our only suggestion for improvement would be to add diagrams comparing the fetal development of male and female external sex organs to show their basic relatedness.

Title: Biology, 5th Edition (1983)
Author: John W. Kimball
Publisher: Addison-Wesley Publishing Company, 2725 Sand Hill Road, Menlo Park, California 94025

This 974-page is divided into nine parts, 46 chapters and organized functionally. Part I (2%) provides an introduction and chapter on scientific methods.

Part II (8%) introduces the chemical and cellular basis of life. Part III (9%) develops the theme of cellular physiology including metabolism, photosynthesis and division. Genetics, from classic to DNA organization in eucaryotes, is covered in Part IV (12%). Reproduction and development follows logically in Part V (9%). Part VI (14%) covers regulating the internal environment including nutrition, gas exchange, circulation, immunology and excretion. Part VII (16%) treats responsiveness and coordination including behavior. Evolution and classification of life are combined in the largest unit, Part VIII, 18%, with evolutionary theory taking three chapters. Part IX (12%) develops ecological principles ranging from energy flow through cycles in the biosphere to populations; human ecology is covered in two chapters.

This is the quintessential college biology textbook; it is a virtual encyclopedia of modern biology knowledge. Using a combined functional and structural approach, the author moves from the molecular through cellular and organismal levels to the level of populations and the environment. At the same time functions of individual living systems are interwoven, including genetics, reproduction, development, homeostasis and responsiveness. This is pedagogically sound, and provides students with a logical frame of reference.

Chapter 2, Scientific Methods, discusses hypothesis building and testing in the context of a simple but real problem in immunology: the development and control of contact sensitivity, i.e., poison ivy allergy. Although the hypothetic-deductive method is accurately described, the author fails to develop the concept of a scientific theory. Even the word is not defined in the extensive glossary. We find this to be a serious omission in a college text and urge the publisher to correct this deficiency.

Evolutionary theory is developed in a classical manner, commencing with a review of evidence for evolution emerging from fossil study, comparative embryolgy, anatomy, biochemistry, geographical distribution and domestication. The mechanisms of evolutionary change are discussed in a separate chapter considering the concepts of natural selection, population genetics and speciation. An additional chapter reviews hypotheses on the development of life on earth. The unit concludes with a review of earth-life using the favored five-kingdom approach. Modern evidences for evolutionary relationships such as amino acid substitutions in proteins and chromosome structure are covered in addition to traditional evidence. We did not detect any soft pedaling of evolution often found in lower-level biology textbooks. Extensive presentation of data plus an "if...then..." writing style gives students a firm understanding of how scientific knowledge is accumulated.

This textbook will find favor with teachers who are instructing advance placement courses. It provides a sophisticated, thorough review of biological knowledge.

Testimony By Others

RECOMMENDATIONS TO THE TEXTBOOK COMMITTEE
OF THE STATE OF TEXAS
CONCERNING THE 1984 BIOLOGY TEXT CHOICES*

Introductory Biology, Biology I and Biology II
by
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July 11, 1984

Since receiving my doctorate in zoology 27 years ago I have been on the faculty of the University of Texas at Austin. There I have taught several different courses including introductory biology, invertebrate zoology, and ecology. I speak for myself.

GENERAL COMMENTS

All of the textbooks proposed for adoption have been examined and advice obtained from a highly skilled, experienced and very well-regarded teacher of high school biology. Evaluations of the quality of the texts were made on the basis of:

1. The degree to which the text reflects modern biology (as it is regarded by people doing research and teaching in the field);

2. The integration of the text so that relationships between the various forms and functions of (various) organisms can best be appreciated by the student;

*Edited slightly to remove commentary on three textbooks which were disallowed by the Texas Commissioner of Education on the grounds that the publisher did not provide a teachers edition.

3. The degree to which the text (and questions and activities) encourages students to think carefully about biological problems (rather than simple regurgitation of names, processes and the like);

4. The treatment of "how science is done" (the scientific method); and

5. The treatment of evolution (biology's backbone so to speak), including its utilization in helping to tie the parts of the whole together into a coherent and sensible story.

There are a few improvements which need to be made in the discussion of the scientific method as it is usually presented in these books. The students need to be told the first thing one must do if one is to carry out science is to learn a lot about the subject which is of interest. Only then will it be possible for the investigator to ask questions (propose hypotheses), the testing of which will have a good chance of providing answers which will tell us more than we already know about how (some part of) the world works. It is possible, as a number of the texts illustrate, to ask the student (at least rhetorically) to erect hypotheses, but note that these are almost always trivial and frequently have to do with very simple, physical systems. What this reflects is the reality that one must learn a lot before one can really become a scientist.

There is another important aspect of science which I did not see discussed in any of the texts. Like an artist, a scientist strives to put together sometimes apparently unrelated or disjointed pieces with the goal of creating a pattern which is meaningful, sometimes exciting and never seen before. The creative experience the scientist has when this is accomplished is very similar to an artist's when he puts together initially unrelated dabs and smears of color to produce a magnificent painting. The drive to repeat this very rewarding creative experience is one of the important factors leading many scientists to work as hard as they do. Students should be told about this important aspect of scientific work.

Finally, there is an additional shortcoming to most of the scientific method discussions: they omit the important step of reporting about the work accomplished, generally by publishing papers about it. Only in this way will the rest of the world learn from the scientist's work. Usually it is only after publication that there can be the most effective interaction among scientists resulting in further confirmation (or denial of) the scientist's conclusions. Only when scientists check on the thinking and experimental/observational methods

of each other can the very important self-correcting characteristics of science be most efficiently brought into play. This self-correcting nature of science (and how the process works) are not considered in most of the textbooks which have been submitted.

I recommend the Textbook Committee ask publishers to include more of these important discussions in their biology books.

Introductory Biology

It appears to me that all of the submitted texts, taking into account the level appropriate for the students for which they are to be adopted, inadequately reflect the content of modern biology.

One of the other deficiencies of all of these texts is that they fail to adequately incorporate evolution which is the major integrating paradigm of modern biology into their discussions. (The use of phylogeny also provides a powerful additional pedagogical value, especially in helping students appreciate the patterns of similarities and differences particularly among animals as well as some of the reasons for the patterns' existence. The book by Tanzer/Prentice Hall is best on evolution, then (considerabley poorer) come those by Wong/Prentice-Hall; Teter/Holt; Rinehart, Kaskel/Merrill; and Alexander/Scott, Foresman. The others ignore the subject. None of these texts provides any of the important and valuable fossil-derived evolutionary trees.

If it is decided at least one book must be chosen from this list, the Prentice-Hall book by Tanzer should be chosen with the provision that the aforementioned deficiences be remedied. Otherwise, one or more of the books which have been proposed for Biology I could be appropriate (Otto/Holt and McLaren/Heath are suggested except the former should use "amoeba," NOT "ameba"!).

Biology I

There are some excellent books which have been submitted for Biology I. The best group of these, in descending order of quality are: BSCS Green Version/Houghton Mifflin; Creager/Macmillan; Kormondy/Addison-Wesley; and Slesnick/Scott, Foresman. These four are highly recommended for adoption. Of distinctly lower quality than the group just listed are: Oram/Merrill; Otto/Holt, Rinehart; and McLaren/Heath. As already noted, the books by Otto and McLaren are recommended for adoption for introductory biology. The last group, which I recommend should not be approved since they are decidedly inferior include Baur/Laidlaw and Gottfried/Prentice-Hall which is full of errors.

Biology II

All three texts submitted for Biology II are excellent for that level of work, and I recommend all be adopted.

Finally, I commend the Textbook Committee members for your willingness to put a lot of your time and effort into working toward ensuring the textbooks our children will use will be as good as possible. I strongly support your efforts to further upgrade the quality of education in Texas (and America) because I realize, as you do, that we are in a fierce economic competition with people in the rest of the world. It will be only by great effort on our part and on the part of our students that we will be able to hold our own in the future. The quality of our children's thought processes will be crucial, and our schools have considerable affect on how well these thought processes are developed. The quality and quantity of the information at their command and depth and breadth of their understanding of how various parts of the world work may also well be pivotal to the long-term success of our children in this competition.

TESTIMONY TO THE COMBINED HEARING/BY THE COMMISSIONER OF EDUCATION AND STATE TEXTBOOK COMMITTEE/OF THE STATE OF TEXAS*

July 10, 1984

by
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Houston, Texas 77254

Thank you, Mr. Commissioner. I want to tell you I am very appreciative of being able to speak this morning on the subject of the biology textbooks. My name is Steven Schafersman. I am president of the Texas Council for Science Education which is a state organization dedicated to improving science education in our public schools.

Our main interest for the last three years has been the textbooks, trying to improve the content of the topic of evolution in textbooks, as well as improve biology education in classrooms. The organization consists of many industrial scientists, university professors and practicing scientists. I, myself, am an industrial scientist but my research has involved evolutionary paleontology. I am familiar with the topic of evolution and have been defending that topic now for three years here in Texas.

I'm handing out a statement which is not what I am going to speak about for most of my time. This statement will cover some materials on a topic which I may get into at the end of my talk if I have time. I am going to be spending my time on textbooks which I reviewed. Due to time constraints I was not able to read all of the textbooks. I glanced through them and did read thoroughly the textbooks in four areas. These areas are evolution, the origin of life, human evolution and the scientific method. I chose these four areas because these are the topics most subject to prepublication censorship by publishers when they ask the authors to write the books and when publishers edit the books. They try to write the books to appeal to what they think is acceptable in Texas. So I did examine these four areas carefully.

I found many of the books were unacceptable but some were also very acceptable. The books sometimes confused the evidence for evolution with the mechanisms for evolution. They did not use evolution as a theme to tie different aspects of biology together. Classification and taxonomy is not given its evolutionary basis in any textbook. The fact that taxonomists find groups within groups, that is, nested categories of relatedness, demonstrates that life has a history, therefore evolution occurred.

* Transcribed from recorded oral presentation with slight editing by the author.

The description of scientific method is outdated in most of the books. The hypothetico-deductive method is the currently accepted method of science and no one really discussed that properly.

Of most concern to me was that most books had qualifying and misrepresentative statements concerning evolution. Conclusions of science were presented as opinions or beliefs which therefore can be accepted or not as the students choose. These words were used to appease the creationists, and even though the explanation is that they were used to avoid dogmatism, they actually don't. There is nothing dogmatic about the scientific method and the conclusions of science which are based on empirical evidence and logical reasoning. That is science. So, using words like "opinions" and "beliefs" is not necessary. And of course a few books have the disclaimer about the fact and theory of evolution in the preface, which is insulting to scientists and no longer required by the State Board of Education in any case.

Now, I am going to go through these in detail, providing the evidence for some of this. Let me start off with Introductory Biology. At first I thought I was reviewing junior high school books, and in fact in most cases they were. These books are to be used in high schools to perpetuate the myth for some students that they are getting a high school education. They are not really acceptable at the high school level. I agree with People For The American Way and Dr. Bassett Maguire that the only barely acceptable book is Prentice-Hall's book Biology and Human Progress by Tanzer. The other books are just not acceptable at the high school level. This course, in fact, should not be taught in high schools. This two track system is misplaced concern. Students going to high school need a good biology course; this is the science course they will look back on for the rest of their lives.

Now lets jump up to Biology II. All three books were superb. They were excellent, college-level books. Biology II is a college-level course which students in high school study in order to take the advance placement exams for college. These books are superb, so I recommend all three.

Now lets get to the Biology I books. These are the controversial books. Some of these were excellent, others extremely poor. The two best books which I unreservedly recommend are Houghton, Mifflin's, the BSCS Green Version, Biological Science: An Ecological Approach, which had no obvious errors all. The book by Macmillan, Biology, written by Creager, was also an excellent book. I recommend those two unreservedly. Macmillan had three chapters on evolution. They discussed Darwin, natural selection and the fossil record in an excellent way.

The next three books I am going to recommend are marginal. Scott, Foresman's Biology by Slesnick does not cover human evolution; that is bad. The description of scientific method is inaccurate and will have to be rewritten. It does use qualifying statements such as "scientists think" or "scientists believe" rather than "scientists conclude" based upon empirical evidence, logical reasoning and so forth. For instance, "Homology does not prove evolution. Nobody has actually seen reptiles with forelimbs give rise over millions of years

to birds with wings or whales with flippers" (page 209). That nobody has seen this is not relevant to the fact that it occured. All of science is indirect observation, and deduction from hypotheses which are then tested. Every particle, every atom has a history and even though this is historical, it should not be compromised as it is here. Otherwise it is an excellent book.

The Addison-Wesley book is also fairly good, strong in many areas. But the topic of evolution is confined to one chapter with no mention of it or its relevance to the rest of biology throughout the rest of the book. There is no mention of human evolution. These problems should be corrected if it is going to be accepted. However, unlike most of the other books there are no misrepresentative or qualifying statements to dilute the topic of evolution and scientific accuracy.

The Heath book does not correctly explain the hypothetico-deductive method. It discusses the origin of life, human evolution and the evidence for these in a very good manner. It does have the Texas disclaimer in the preface that evolutionary theory should not be treated as fact despite the fact that evolution occurs. The theory should not be treated as fact, of course, but it still misrepresents what scientists understand evolution to be. It is a natural process that occurs in nature.

All of the other books are, to my mind, unacceptable without extensive and major revisions. Holt, Rinehart & Winston's Modern Biology does not explain the scientific method properly, presents scientific conclusions on evolution as mere opinions in every case, and constantly qualifies or misrepresents them. For instance, "Scientists believe that the history of the earth began about 4.5 billion years ago." Well, that is hardly a belief. Every scientist accepts that; it is unquestioned. "Angiosperms are thought to have developed from a primitive gymnosperm." "The earliest vertebrates are thought to have been aquatic." "It is thought that fishes evolved from simple, primitive chordates." Now these are conclusions of scientific reasoning and scientific investigation. Archeopteryx is presented as the earliest bird when in fact it is as much reptile as bird. In Merrill, Biology: Living Systems, the publisher presents scientific conclusions as opinions and uses the Texas disclaimer. This book is unacceptable without extensive revision.

Prentice-Hall and Laidlaw are totally unacceptable. They are full of errors. Laidlaw was written just to appease the creationists; its evolutinary chapter is terrible.

So, I recommend two Biology I books unreservedly and three marginally. Since I am almost out of time, let me just say in answer to some of the claims made earlier this week that the idea of a compromise to teach evidence against evolution is absurd because there is no scientific evidence against evolution. Thank you.

Creationism Refuted

Rebuttal to Creationist Testimony on Biology and Science Textbooks

Presented To The Texas State Board of Education, July 1984

When reading the extensive comments submitted by Mr. and Mrs. Mel Gabler and Professor Neal Frey on elementary science and biology textbooks--41% of the total testimony submitted by all petitioners--one is compelled to wonder what the scientific credentials of these petitioners and the more than 10 other people presenting creationist views are.

- Do they posses degrees in biology indicating years of intensive study?
- Have they published their views and had them criticized by members of the scientific community?
- Do they cite sources for their quotations and paraphrasings so that a critical reader may verify their statements?

These are perfectly reasonable questions to ask of anyone who sets him or herself up as an authority, whether that person claims to be a doctor, teacher, lawyer or member of the clergy. When these questions are asked of these petitioners, each must be answered with a clear "no."

We submit to you that the comments of Mr. and Mrs. Gabler and Professor Frey demonstrate scientific illiteracy. These people have not spent years studying biology; their unorthodox views are either unknown to science or were rejected as unsupportable years ago. Nor do they provide citations making it possible to check the validity of their references to and interpretations of other peoples' work. Professor Frey does not now hold academic rank at any institution and when he did, he taught history at Christian Heritage College in California--home of the Institute for Creation Research. When presenting arguments against accepted scientific views, they refer to outdated reports while ignoring volumes of modern

reports. They misapply scientific words which have precise meanings while inventing new terms to describe nonexistent phenomena. We see no reason for taking their interpretation of biology any more seriously than the arithmetic of someone who insists that 2 + 2 = 5.

It has been claimed by Mr. and Mrs. Gabler and Professor Frey that Attorney General Mattox's opinion (JM-134, March 12, 1984) establishes that "the scientific factuality of evolution is not proved beyond reasonable doubt." We fail to find any evidence of this notion in the opinion. What we did find is that the Texas Board of Education has engaged in unconstitutional rulemaking at the behest of creationists including the Gablers. The significant quotation is not the one included in the Gablers' comments on Biology and Elementary Science Textbooks, but this one, where Mr. Mattox quotes from the opinion handed down in Wright v. Houston I.S.D. (1972):

> Scientists and religion necessarily deal with many of the same questions, and they may frequently provide conflicting answers. But, as the Supreme Court wrote 20 years ago, it is not the business of government to suppress real or imagined attacks upon a particular religious doctrine. . . .Teachers of science in the public schools should not be expected to avoid the discussion of every scientific issue on which some religion claims expertise (emphasis added).

The Gablers and their supporters are continuing to pursue their unconstitutional goal of suppressing the teaching of evolutionary theory in order to maintain their particular religious beliefs, unchallenged by the findings of science. In fact, their comments are nothing less than a brazen attempt to rewrite science and evolutionary theory so that young-earth creationism--not science--is advanced.

The question that you, as a member of Textbook Committee must decide is, where do you wish to buy your science education? From creationists lacking expertise in either science or biology? Or from scientists who are devoting their professional lives to understanding our world? Let's put the question another way: Who should define science--people who believe they are on a religious mission or people who are practicing science? Compromise on this issue is not possible. You must commit yourselves one way or the other, for science is a whole fabric and tampering with one section--evolution--will distort everything else you attempt to teach.

Modern Evolutionary Theory

In order to effectively criticize the comments submitted by the Gablers and their supporters, it is important to first describe modern evolutionary theory. Only then will creationist comments be seen for what they are: a clever attempt to obscure real science with a pseudoscientific smokescreen.

The accepted definition of biological evolution among practicing scientists is simply "descent with modification." That is, species of interbreeding living things can give rise over time to one or more different species. Such a concept flies in the face of everyday experience which tells us that dogs give rise to

dogs, not cats or foxes. Each species appears to be quite constant through time, or at least through a human lifetime. Wherever did a notion like evolution come from? It came as an answer to three questions raised by 19th century naturalists:

1. How can we account for the extraordinary diversity of life on earth--more than 2 million different species?

2. How can we explain the remarkable adaptations of living things such as birds which possess feathers, hollow bones and special respiratory apparatus, all adaptations for flight?

3. Why is there a "scale of nature" seemingly extending from simple to complex species, as among vertebrates that progress from sharks through dolphins to great whales?

In addressing these questions, Darwin and all scientists are restricted in their explanations by this one requirement: they must be testable. As Thomas Hunt Morgan, the founder of modern genetics wrote: "It is the prerogative of science...to cherish those [hypotheses] that can be given an experimental verification and to disregard the rest, not because they are wrong, but because they are useless." Darwin began, therefore, by testing the hypothesis of natural selection as the long-sought mechanism of biological change. He and others did this by making deductions from his hypothesis and then checking their validity by observation.

If the hypothesis of evolution by natural selection is true, then there must be variation among organisms. Using domesticated animals and cultivated plants, Darwin clearly demonstrated that organisms do vary and that these variations can be preserved by artifical selection. In nature he found that there was remarkable variation within a species ranging from variations among populations through distinct subspecies, and that the concept of a well-defined, immutable species was not borne out by careful observation. Since each organism produces many more offspring than can possibly survive, there must follow a great dying off within each generation. He then argued from the analogy of artificial selection that nature (the environment) selects and conserves those heritable variations which favor survival within a population. It was on this logical argument that he rested his case. The supporting data came later.

If the hypothesis of evolution by natural selection is true, then there must be differences among the offspring that survive and reproduce and those which do not. Today we can cite many instances of differential survival, and most biology textbooks do. Industrial melanism expressed in peppered moth populations of England, development of DDT resistance in house fly populations and bacterial resistance to antibiotics are usually mentioned to support this deduction.

If the hypothesis of evolution by natural selection is true, only those variations which are inherited will be important. In his Origin of Species, Darwin noted, "Our ignorance of the laws of variation is profound. Not in one case out of a hundred can we pretend to assign any reason why this or that part differs, more or less, from the same parts in the parents."

This is no longer true. We now understand that genes are sequences of DNA which code for sequences of amino acids (sequences which occur in polypeptides and proteins) that determine the expression of hereditary traits. Thus there is a gene in peppered moths which controls the sequence of metabolic events leading to the production of the pigment melanin which causes the possessor to be dark colored rather than light. Both the gene for dark-colored moths and the separate gene for light-colored moths were present in the population, but the light-colored, lichen-covered trees on which the moths rested in daylight favored survival of light-colored moths. Birds which fed on the moths preferentially ate the easily seen dark form thereby reducing the frequency of the dark gene. When industrial pollution killed the lichens and darkened the trees, dark-colored moths were favored as the more easily seen lighter form was preferentially eaten. Now that the British government has established smoke-free zones, the lichens have returned to some areas and the local moth population has shifted back to the predominately light-colored form.

We also know mutations can change a gene in the metabolic pathway leading to melanin profoundly that its protein product ceases to function or functions in a new way. In the modern synthesis of evolutionary theory introduced in the 1930s, mutations came to be viewed as the principle source of variation within a population. That most mutations appear to be harmful--an observation gleefully noted by creationists--is actually a requirement of modern evolutionary theory which states that all useful variations for a particular environment have already appeared and have been conserved. Additional variations (mutations) must therefore be nonadaptive. There are also many mutations which are neutral and potentially helpful, many of which are too small or subtle in effect to have been observed in the absence of current techniques.

There is a very common problem in high school biology texts that neither mention nor explain any of the well-understood mechanisms by which the amount of genetic material may change in a species (or lineage) through time. These include gains and losses of DNA by unequal crossovers, replication errors of the chromosomes and the activities of transposable elements. One kind of evidence for the existence of such mechanisms is the presence of duplications in all eucaryotic genomes which have been examined for them. At least some of these mechanisms should be discussed since they are necessary for the development of important and otherwise inexplicable patterns of differences in the amounts of DNA in different kinds of organisms. Any survey of modern biology which does not include such discussion is inadequate.

If the hypothesis of evolution by natural selection is true, then close examination of a species should reveal a range of subpopulations which are incipient species. This is in fact so, although only the Houghton Mifflin (BSCS Green Version) and Scott Foresman (Biology) textbooks develop this concept. Both books use the example of the salamander Ensatina eschscholtzi, although other cases are well known.

If the hypothesis of evolution is true, then we should find evidence for it in organisms that lived in the past. Specifically, we should find that the species that lived in the remote past must be different from the species alive

today. In addition, the older the sedimentary strata, the less chance there should be of finding fossils of species alive today. Both of these predictions are amply supported by the fossil record. Primitive horses are found in upper strata (Miocene), dinosaurs in lower strata (Cretaceous), early amphibians in still lower strata (Devonian) and trilobites among the lowest strata (Cambrian). This sequence is never out of order anywhere in the world without accompanying evidence of shifted layers (i.e. overthrusting). The absence of this finding would be evidence against evolutionary theory.

If the hypothesis of evolution is true, which assumes that all of today's species are the descendents of a few original forms, then there should have been connecting forms between the major groups (phyla, classes, orders). Darwin argued that geology fails to reveal a "finely graduated organic chain" because of the chancy nature of fossilization and later recovery. Furthermore, the major phyla were all established and represented in the Paleozoic strata, meaning that the ancestral population of any two phyla would have lived at a yet earlier time. Recent research on ancient strata (Ediacarian and earlier) is yielding exciting results and we may yet learn more about the origins of phyla. Nevertheless, we have learned a great deal about evolutionary lineages among the vertebrates (phylum Chordata). This phylum offers two advantages over earlier life: bones and teeth are easily fossilized and the chordates are the most recently evolved animals. Among the vertebrates, Archaeopteryx is correctly cited as a major transitional form between reptiles and birds--the "smoking gun" sought by Darwin. Here is a fossil which combines the characteristics of modern birds (feathers, wings) with those of ancient reptiles (anatomy, teeth). It is a true intermediate form between two orders of modern vertebrates.

If the hypothesis of evolution is true, then the age of the earth must be very great, possibly many millions of years old. The evidence for an ancient earth is overwhelming and has caused more problems for creationists than any other data. The Gablers, for example, devoted one page in their handout to the Textbook Committee at the July 9th hearing in an attempt to discredit the carbon-14 dating technique. (Carbon-14 dating technique is useless for any ages over 50,000 years and or any sample that does not contain original carbon.) The methods for dating igneous rocks, based on different isotope ratios such as uranium-lead and potassium-argon, are accurate within a 1% error. Add to this sophisicated data the common sense observation of the Grand Canyon and one has to be convinced the earth is very old, certainly much older than 6,000 years as some creationists have proposed.

There are several other deductions from the hypothesis of evolution which can be tested by observation. They are frequently described in high school biology textbooks as "evidence for evolution."

If the members of a taxonomic unit such as phylum Chordata share a common ancestry, that should be reflected in their structure. Drawn from comparative anatomy--formerly a major activity of biologists--the concept of homology is recognition of similar parts in different organisms. The flippers of whales, fore limbs of horses, and arms and hands of humans have similar structure and embyonic origin, although they serve different adult functions. Much more can be done with data on homologous structures than is common in introductory textbooks.

If the members of a major taxonomic unit share a common ancestry, that should be reflected in their embryonic development. Although study of comparative embryology in the last century led to the extreme statement by Ernst Haeckel that "ontogony recapitulates phylogeny," all vertebrates share features of embryonic development. The closer the taxonomic relationship, the more features are shared. Thus human development closely resembles that of chimpanzees, less so that of dogs, and still less that of chickens. Nevertheless it is accurate to say all vertebrate embryos trace the same general pathway of early development and diverge only at later stages.

If evolutionary divergence is the basis of organic diversity, that should be reflected in our system of classification. Although we can certainly classify organisms without any understanding of evolution whatsoever, as was the case with early taxonomists, we should be very surprised if our classification system--based on shared characteristics--did not reflect evolutionary relationships. Careful, independent classification based on comparing DNA and proteins either supports hypothesized evolutionary relationships or suggests new lines of investigation which lead to a revised hypothesis of evolutionary relationships.

If there is a unity of life based on evolution, that should be reflected in the molecular processes of organisms. Here is only some of the modern evidences supporting this prediction:

1. All life on earth is based upon the same classes of organic compounds: nucleic acids, proteins, lipids and carbohydrates.

2. DNA is the universal heredity material, coding the information that regulates life.

3. The triplet code of DNA which is related to specific amino acids is the same for all life.

4. The same 20-odd amino acids are used to make proteins in all life.

5. The match of amino acid sequences in specific proteins (i.e. hemoglobin and cytochrome-c) is closest between members of the same genus, grading off when higher taxa are compared.

6. The same is true when nucleic acid sequences in DNA are compared.

Taken all together, the evidence supporting predictions derived from the hypotheses of evolution and natural selection is very good indeed. Steven Weinberg, Nobel laureate in physics at the University of Texas in Austin, has said in this regard, "...like the atomic theory, there is the theory of evolution without which you cannot imagine modern biology...(it) is as certain as anything can be in science." (Talk presented Nov. 9, 1983, Conference on Evolution, Science Teaching and Textbook Selection in Texas.) There are many details to be filled in, such as the exact human evolutionary lineage, but the overall picture--that evolution has occurred--is certain beyond reasonable doubt.

(In developing the foregoing summary of evolutionary theory we are deeply indebted to Dr. John A. Moore and his essay, "Science as a Way of Knowing--Evolutionary Biology," which appeared in the American Zoologist, Vol. 24, No. 2, 1984, pp. 467-534.)

Gabler Evolutionary Theory

The first conclusion to be drawn from the Gablers' submission is that they have only one interest: the treatment of evolution. Although they quote the attorney general's opinion in their comments on each book reviewed and refer repeatedly to it, they fail to heed his stricture against singling out one theory of biology for unique treatment. By dwelling exclusively on supposed errors in presentation of evidence for evolution and demanding extensive corrections, they are attempting to make the Textbook Committee an accomplice in their campaign to undercut evolutionary theory. We hope the committee does not mistake their submission as an effort to improve science education.

The second conclusion one reaches when reading the 414 pages of comments on biology and science textbooks Mel and Norma Gabler submitted is that they are now using a word processor. One is struck by the repetitious comments identical whether the petitioners are discussing a sophisticated, college-level textbook submitted for Biology II or a simplified textbook submitted for Introductory Biology. The sum of their comments, when extracted from the extensive quotations from the textbooks and shorn of redundancies, encompasses only a few pages. We will respond to the more critical points they raise. In so doing we have taken the liberty of lifting their comments out of their original context, where they relate to a specific textbook, the better to consider their scientific and pedagogical merits. Since their comments are repeated, verbatum in many cases, we see no reason to consider each textbook separately in submitting our rebuttal. In the original text where specific textbook titles were inserted, we have indicated the omission with (_____).

The Gablers Define Evolution

> COMMENT: _____'s repeated definition of "evolution"as mere biological "change over time" is inaccurate enough to include even such obviously unevolutionary phenomena as cumulative genetic decay (e.g., sickle-cell anemia) and adverse mutagenic effects of environmental hazards. _____ must clarify its definition of evolution to denote quantitative (vertical) increases in organic complexity via mutation, producing new genera, families and orders, as distinguished from qualitative (horizontal) variation within species involving no net increase in genetic complexity.

Sickle-cell anemia describes a human genetic disorder which is lethal in the homozygous condition but which has survival value in the heterzygous condition since it imparts partial immunity to certain forms of malaria. Because people who do not carry the sickling gene are susceptible to malaria, the sickle-cell gene has survival value for populations of humans living in malaria zones. This is natural selection at work and decidedly an evolutionary phenomenon. We have

no idea what "cumulative genetic decay" means. The accepted and used definition of evolution in science does not contain any reference to the direction evolution must take. Natural selection has frequently favored simplification, as in the case of blind cave fish that have lost their eyes. The Gablers' definition of evolution does not emerge from science.

> COMMENT: None of the specific examples of genetic variation or mutation which _____ cites in these passages (e.g., DDT-resistant mosquitoes, Darwin's finches, peppered moths, breeds of dogs, Kaibab and Abert squirrels, Australian marsupials) involve any net increase in genetic complexity. Some are not even examples of speciation. _____ must explain that mutations add no information to a gene pool beyond what was already at least latently in the gene pool before the mutations--and may reduce this information. Nor do mutations introduce into an organism's ability to survive features outside its previous genetic potential to develop. In short, none of these examples of variation or mutation is an increase in genetic complexity. They represent merely the adaptation of an established form of life to a new environment. _____ should either furnish valid examples of net increases in genetic complexity via mutation or delete references to common ancestry and evolutionary kinship among genera, families and orders.

The Gablers' argument that evolution must involve an increase in genetic complexity (whatever that means) is spurious. The emergency of a new species requires only that a barrier to natural interbreeding be established between two populations. This barrier can be behavioral (for example, different mating rituals), genetic (different chromosome number) or structural (mismatched sex organs). "Genetic complexity" is irrelevant and emerges from the mistaken notion that evolution must lead to higher levels of organization.

Second, their assumption that mutations are the sole source of genetic variation within a population ignores the well-known effects of gene duplication, chromosone duplication, chromosome breakage and translocation, all of which have the potential of increasing the genetic complement of a population. Thus by using an erroneous definition and ignoring data, the petitioners arrive at the fallacious conclusion that evolution is impossible. This does not surprise us, for their well-known creationist position precludes any other conclusion. Their version of biology permits variation within the vague limits of the originally created "kinds." In this case they appear to be equating "kind" and "genus."

> COMMENT: _____ defines "divergent evolution" as "the development (or evolution) of many different species from a common ancestor"--in short, speciation. Previous comments have shown that use of the term "evolution" in this context is a scientific misnomer since recombination and mutation involve no net increase of genetic complexity (which real evolution requires), so we are really speaking here of lateral differentiation (i.e., speciation) rather than of true vertical development.

We have already commented on the pyramid of errors involved in the Gablers' argument leading to their conclusion evolution is impossible. They are now introducing two new terms of their own invention: "lateral differentiation" and "vertical development." Such terms have no scientific meaning in this context. Evidently, the Gablers equate "real evolution" with "vertical development" which they conclude is impossible, leaving only "lateral differentiation" (speciation).

This is simply a new variation of the old creationist argument that "a dog is a dog and a cat is a cat, and no one has ever seen them change into something new." The Gablers are forced to admit, however, that some evolution (which they attempt to define away as "lateral differentiation" or "cumulative genetic decay") is permissible. The problem with this admission is the same as that of the camel with his nose in the tent: there is no way to limit evolution once it is admitted.

The Gablers Interpret the Fossil Record

COMMENT: _____'s presentation only of the evolutionary interpretation of the fossil record as fact ("fossils indicate that many different things have existed on earth at different times") indefensibly shields students from several major scientific problems confronting that record from the evolutionary perspective. These scientific problems include:

1. Inconsistent Fossil Content and Sequence of Strata in the Standard Geological Column.

   No actual single example of the entire standard geological column exists in nature. The purported evolutionary ages of rock strata do not always match the purported evolutionary ages of some of the fossils they contain. Allegedly "younger" strata sometimes contain allegedly "older" fossils, or underlie "older" strata. Supposedly "older" strata sometimes contain supposedly "younger" fossils.

2. Subjective Structure or the Standard Geological Column

   The age of a rock determines its position in the Standard Geological Column. But the age of rock is determined in turn by the stage which its "index fossils" represent in the presumed evolution of life. Thus the Standard Geological Column reflects evolutionary assumptions but does not prove them.

3. Sudden Appearance of Complex Life Forms in the Fossil Record .

   The "earliest" fossils are as structurally complex as their modern counterparts, and the kingdoms, phyla and classes which first appear in the fossil record are the same which still exist today.

The Gablers begin by confusing scientific fact (the existence of fossils) with scientific explanation ("fossils indicate that many different things have

existed on earth at different times"). They then proceed to cite three "problems" which they feel weaken the evolutionary position while presumably strengthening that of creationism. We do not know what the "Standard Geological Column" is.

The earth is too geologically active for any particular place to have remained undisturbed for billions of years. There are examples where younger strata underlie older strata, but such cases are always accompanied by evidence for overthrusting. That is, movements of the earth's crust have fractured and shoved one sequence of strata over another. This observation is presented in Houghton (BSCS Green Version) on page 321.

Their second point, that the age of a stratum determines its position in the geological column but the age in turn is determined by index fossils, is in error. The position of a stratum determines its age relative to all other strata --not its absolute age. Index fossils are just that: a unique array of fossils associated with a given stratum which permits identification of strata from that period wherever they occur on earth. This method of identifying and correlating geologic strata was developed in the early 1800s completely independent of any notion of evolution. It is used because it works, not because it reflects evolutionary assumptions.

But this question remains: why are there index fossils unique to particular geological strata? Creationism predicts the same fossils should appear in all layers, but a hypothesis of evolution predicts that life changes through time and with it fossil remains, just as shown by index fossils.

Creationists are fond of the phrase, "sudden appearance of complex life forms in the fossil record." It has a nice ring, but what does it mean? The history of earth-life as recorded in the geological strata is incomplete and the older the geological strata the more incomplete it is. Examples of Ediacarian fossils (670 million years old from the early Paleozoic era) are rare but more are being found and studied. A new view of early life is emerging suggesting that the once dominant Ediacarian life was complex but built on a flattened fern-like plan which was later replaced by organisms designed around a more cylindrical body plan and possessing hard body coverings. This took place over some 15 million years, hardly a "sudden" appearance. Data are scanty from the early period of earth-life, but we are learning more and can expect many "gaps" to be filled in as years go by.

> COMMENT: _____ presents as fact only the evolutionary time frame of millions and billions of years in describing the origin and existence of life forms on earth.
>
> Lord Kelvin showed in 1897 that 40 million years is the maximum amount of time the earth could have taken to cool from an originally molten state to its present temperature....Even factoring in heat produced by radioactivity in the earth's crust gives a maximum earth-age of only 50 million years--still well within the Cenozoic.

> Second, data show that the sun's diameter is currently shrinking at least 0.01% per century. Extrapolation suggests that at this rate, the earth would have been too hot to support life more than several million years ago at most. Other scientific data which do not correlate with an earth age of billions of years include the small amount of atmospheric helium compared to its known rate of decay from uranium and thorium, and the small amount of seawater minerals and seabed sediment compared to their known rates of accumulation. This text's citation of an earth age of billions of years ignores reputable nonradiometric earth-age indicators. It is further disturbing evidence that unscientific preconceptions transcend this text's commitment to truly free inquiry.

The best evidence for an ancient earth (approximately 4.5 billion years) has accumulated in the past 40 years, yet the Gablers ignore this modern work and hark back to a calculation made in 1897. Doesn't that strike you as odd? The reason is simple: There are no other data which even remotely suggest a young earth on the order of 10,000 years as required by creationist premises. The Gablers admit that heat from radioactivity could slow the cooling rate, but they restrict such radioactivity to the earth's crust rather than extending it to the earth's interior. Hence their limit of 50 million years. Lord Kelvin, incidently, set the age of the earth at 100 million to 200 million years, not the 40 million reported by the Gablers. Later, revised calculations of heat flow put the upper limit at 10 million to 20 million years. We now know that all four of Kelvin's assumptions (a solid earth, uniform heat capacity and conductivity, uniform initial temperature, and no heat being added as by radioactivity) were wrong. Stephen Brush wrote an excellent review of the subject for Scientists Confront Creationism listed in the bibliography.

We are surprised at the Gablers willingness to extrapolate the rate of shrinking of the sun back billions of years but choke at extrapolating the decay rates of radioisotopes--a much more stable phenomenon--over this same time span. Their remaining objections have all been dealt with in the existing scientific literature, for example, in the book by Norman Newell listed in the bibliography.

> COMMENT: This attenuated discussion of radiometric dating methods contradicts relevant scholarly monographic data on the subject and contains factually erroneous information. It simply is not true that potassium-argon, rubidium-strontium, and uranium-lead dating methods give mutually compatible--or even consistent--figures for the same object, or even for different samples of the same object...
>
> COMMENT: _____ systematically conceals from students the problems and the tentativity of C-14 dating. Among these are the strong possibility that an equilibrium has not yet been reached between the rate of creation of C-14 in the upper atmosphere...

The age of the earth as determined by modern methods is a major problem for creationists who conclude a priori that the earth is very young, on the order of 10,000 years. They defend this position in the face of overwhelming contrary

evidence by simply denying the accuracy of all absolute dating methods. (How they deal with relative dating methods has already been discussed.) We maintain their arguments about the accuracy of radioisotope dating methods are without merit, but if you have questions, we urge you to read relevant chapters in one of the books listed in the bibliography, such as the one by Newell.

We do have a problem with the emphasis that most textbooks give to the carbon-14 method, not because of imagined errors but because it is irrelevant to dating geological strata. Organic carbon must be present for the method to work and the upper limit is only 50,000 years. Other methods such as potassium-argon ratios should be discussed instead.

The Gablers' View Of Transitional Forms

> COMMENT: This hypothetical scenario postulates an example of real evolution. But _____ presents it here as fact without citing empirical evidence to support it or relevant scientific counter-evidence against it...
>
> Furthermore, the allegation that many transitional forms exist in the fossil record between genera, families, orders and classes is patently absurd. It is this systematic absence of transitional forms which "punctuated equilibrium" theory has recently been devised to explain.

Here we are, back to "real" evolution and its presumed counterpart, "false" evolution. According to Gabler biology, evolution ("lateral differentiation") can only occur within a genus; evolution of a new genus or any higher taxon is impossible ("vertical development"). We have already pointed out that mechanisms for increasing the genetic complement of a population do in fact exist.

Transitional forms and their apparent lack in the fossil record have been thrown up by critics of evolutionary theory since Darwin's time. His answer was straightforward: the fossil record is incomplete and further study will reveal transitional forms between higher taxa such as between reptiles and birds. In fact, such forms do exist and are well known to both paleontologists and the general public. (The birdlike reptile Archaeopteryx is a prime example.) They have proved to be a keen embarrassment to creationists who tend to dismiss them, as have the Gablers, by labeling their existance as "patently absurd."

Despite known transitional forms, "gaps" (absence of transitional forms) do exist between higher taxa. Taking this as a real observation rather than as an artifact of the fossil record, Steven Jay Gould and Niles Eldredge have proposed that species emerge and persist in punctuated equilibrium with their environment. In this view, the initial emergence of a species may be relatively rapid (on the order of 100,000 years) after which the species exists unchanged for a long period of time. Thus long periods of equilibrium are punctuated by periods of rapid evolution. This is in contrast to Darwin's view that species emerge gradually. The issue is entirely one of rate; natural selection is assumed to operate in both hypotheses. The issue is unsettled but has stimulated new research and is therefore countributing to the growth of scientific knowledge.

COMMENT: Archaeopteryx's teeth, its wing tip claws, are no more peculiarly reptilian features than its lungs and its vertebrae. The hoactzin, a modern South American bird, has similar claws, while teeth were not unique to Archaeopteryx among other extinct birds. The fossil evidence shows Archaeopteryx to have been merely an extinct species of bird, not an intermediate form between reptiles and birds, because (A) all structures of Archaeopteryx were fully functional (including its modern, avian-style asymmetrical wing design), not "midway between those of reptiles and birds" as _____ opines; and (B) fossils of indisputably modern birds exist in the same strata as Archaeopteryx, minimizing the possibility that "reptilelike" Archaeopteryx linked reptiles and modern birds...

Here the basic Gabler argument that existence of intermediate forms is "patently absurd" is extended by an attempt to define a critical fossil out of existence. If it has feathers, functional wings and other features found in modern birds, then it must be a bird. However, this argument ignores all of the reptilian chacteristics also possesed by Archaeopteryx: reptilian anatomy including clawed wings and a tail, teeth, and absence of a well-developed sternum. We agree that all structures of Archaeopteryx were fully functional; that is precisely what one expects if natural selection is the mechanism of evolutionary change. Archaeopteryx thus offers that combination of characteristics one would expect of an intermediate form; no wonder creationists want to define it away. We do not know of "indisputably modern birds exist(ing) in the same strata as Archaeopteryx..."

COMMENT: It is necessary to suppress the fossil evidence to sustain the evolution of the horse. Eohippus--supposedly the horse's earliest ancestor--is almost identical to the modern hyrax. Equus--the modern horse--extends back through all or most of the Pleistocene Era. Among purported transitional forms, Merychippus (with three toes) and Pliohippus (with a single hoof) exist in the same strata, with intermediate fossil links uniformly missing. The evidence points more to coexistent separate species than to evolutionary descent. See Steven Stanley, "Macro-evolution and the Fossil Record," Evolution, Vol. 36, No. 3, 1982, page 464; and David Raup, "Conflicts Between Darwin and Paleontology," Field Museum of Natural History Bulletin, Vol. 50, January 1979, page 25.

Scientists have no problem with the coexistance of ancestor and daughter species. It is in fact exactly what one would predict from modern evolutionary theory: small, isolated populations evolve into separate species possessing new combinations of successful traits. We find several species of antelope coexisting on the African plains and see no problem. Why not several species of ancient horses? Evolution leads to branching descendance, not a straight line to modern species. We can't imagine why the Gablers claim that Eohippus "is almost identical to the modern hyrax." Perhaps they are following the error of the original describer of Eohippus (dawnhorse) who named it Hyracotherium (hyrax-like).

The Gablers Consider The Origin of Life

> COMMENT: _____ fails to appraise the Oparin hypothesis and the Miller-Urey experiment on the basis of the known scientific conditions necessary for the development of life. Specifically, _____ ignores Oparin's failure to identify either an adequate energy-conversion mechanism to harness quantitative solar energy to qualitative evolutionary work, or an adequate informational coding device to direct organic development. Moreover the random assortment of primitive amino acids produced by Miller-Urey: (A) depended on a trap to preserve the acids artificially --"artificially," because to have re-exposed them to additional electrical energy necessary to synthesize them to greater complexity, would have destroyed them; (B) ignored the fact that known acid-base chemical reactions would never align proteins and DNA into organically viable configurations; and (C) included both right- and left-handed amino acids, whereas living things require strictly left-handed amino acids...

The issues the Gablers raise are either trivial or a reflection of inadequate training in chemistry. We fail to understand the insistence on identifying an "energy-conversion mechanism to harness quantitative solar energy to qualitative evolutionary work." The Miller-Urey experiment asks only: can simple organic molecules be generated under conditions approximating these which existed on a primitive earth? The answer is "yes." No evolutionary "work," whatever that may be, was performed. One does not insist on identifying an "energy-conversion system" in order to fix nitrogen by the Haber process (an industrial process for making ammonia from gaseous hydrogen and nitrogen). Why then here? We contend the Gablers' intention is to undermine the Oparin hypothesis by falsely insisting biological structure could not emerge from inorganic molecules without the intervention of a creator. This is borne out by refuting the additional objections of the Gablers:

(A) The Miller-Urey experiment intended to test only the first prediction of the Oparin hypothesis, that organic molecules could accumulate. Fox and others tested additional predictions of the hypothesis, such as the function of natural clays as catalytic agents in the formation of higher order molecules. Tide pools and shallow ponds are certainly the equivalent of a trap.

(B) We are always leery of anyone who uses "never" too freely, as do the Gablers. What is an organically viable configuration? They should demonstrate their contention; that is the way of science.

(C) The right- and left-handed amino acids do raise an interesting question, but it hardly destroys the overall argument. Perhaps some day we will have an answer. (Modern organisms use only "l" form amino acids even though the "d" form is chemically identical.)

> COMMENT: This amateurish speculation on the possibility of extraterrestial life is profoundly unbiological...The mathematical probability of amino acids randomly stringing together into the

simplest proteins, each of course with their requisite DNA, truly verges on absolute zero. Factor into this improbability the number of chance, sequential, beneficial mutations necessary for one molecule to attain the self-replicating level, add the infinitely greater complexity of the higher forms of life, and has (sic) plainly shielded its students from biological reality in this discussion.

Aside from dismissing a noted scientist's work as "amateurish speculation," we are disturbed by the Gablers' misuse of probability. First it should be noted that modern proteins have 3.5 billion years of evolution behind them and are far more complex than need be for basic catalysis. The active moiety of many enzymes is only a few amino acids long, not hundreds. Secondly, the present relationship between DNA and protein need not have existed at the start of life. It is now known that RNA has enzymatic properties, raising the possibility that it was the first hereditary molecule and a catalyst. Again, we challenge the Gablers in the name of good science to demonstrate the impossibility that life originated by mechanistic means without divine intervention. (See the article by Russell Doolittle in Scientist Confront Creationism for further discussion of the formation of living systems.)

The Gablers Present Evidence Against Evolution

COMMENT: With fossil evidence for "convergent evolution" also lacking, _____ fails to distinguish "analogous organs" from "homologous structures," and draws inconsistent inferences from the similarities. Anent homologous structures, _____ states that anatomical similarity and physiological similarity do indicate close evolutionary ancestry. But in these passages _____ states that anatomical and physiological similarity do not indicate close evolutionary ancestry. If, as _____ alleges, homologous/analogous structures do, and do not, indicate close evoluntary ancestry, _____ has introduced an evidential reductio ad absurdum, namely, that evidence against evolution cannot exist. This a priori reasoning is unscientific.

The Gablers have hoisted themselves on their own petard. "Homologous structures" have corresponding anatomical components and similar embryonic origin. Homology is an observation with no necessary relationship to evolution. However, as we pointed out in the section on modern evolutionary theory, "if the hypothesis of evolution is true and members of a taxonomic unit such as the phylum Chordata share a common ancestry, then that should be reflected in their structure."

It is, as is borne out by the observation of homology. Its absence would falsify a hypothesis of evolution. On the other hand, analogous structures share a common function but dissimilar anatomy and embryonic origin. A hypothesis of evolution makes no necessary prediction about analogous structures except to say natural selection works with what already exists and may solve a given problem in more than one way. Analogous structures bear this out but offer no evidence on closeness of evolutionary ancestry.

COMMENT: _____ suggestion that "vestigial organs...provide evidence for evolution" carries the discussion of origins from the plane of inquiry to the level of dogma. _____ elsewhere alleges evolutionary relationships on grounds of anatomical, embryological and molecular similarity among organisms (see immediately above). But here _____ conjectures that physiological (i.e., functional) dissimilarity (e.g., between the human and the rabbit appendix) indicates common origins...

One observer's vestigial organ is another observer's intermediate form. How shall we explain such anomalies such as the human appendix, cocyx or the crossing of our food and air tubes (which occasionally leads to death through choking) except as structures which served other functions in ancestral species? We fail to see any evidence of dogma in the textbook discussion of vestigial organs.

COMMENT: On the subject of embryological homology, _____ appears editorially committed to noting superficial similarities and ignoring functional differences throughout. The "gill-slits" appellation totally misrepresents the known functions of the pharyngeal pouches in human ontogeny. Far from recapitulating fish breathing-apparatus at any developmental stage, these human pharygeal pouches are the antecendent of the thymus gland, parathyroids and middle ear canals. It is unconscionable for _____ to espouse at this late date a modified version of the discredited recapitulation myth, even to lend false aid and comfort to the evolutionary-kinship hypothesis.

Haeckel's Biogentic Law ("ontogeny recapitulates phylogeny") contains an element of truth; the problem with this so-called law was in its over-enthusiastic application by Haeckel and his students, along with over-simplification by textbook writers. The element of truth is that all vertebrate embryos follow nearly identical paths of early development, leading to the basic vertebrate body plan. One by one from there the major orders seem to drop out of the path leading to mammals. Thus, the first gill pouch becomes a gill slit in jawless fish, but goes on to form the eustachian tube of higher vertebrates; the second gill arch goes on to form a bone of the middle ear (the stapes) of mammals. The path followed by all members of a given order is uniform and may be explained in terms of evolution as selection of existing structures for new uses. Thus one perceives a progression when comparing vertebrate development rather than recapitulation.

COMMENT: Far from suggesting close evolutionary relationship and common ancestry, the DNA coding for each type of embryo differs profoundly--at least as indicative of separate origins as of a single evolutionary prototype.

The modern evidence for evolutionary relationships began to accumulate in the 1950s when it became clear that DNA is the universal hereditary material. Since then techniques for comparing DNA sequences have been refined to the point where specific genes may be compared, base pair for base pair. The significant findings for an introductory text are: (1) The close correlations of DNA between members of the same genus; and (2) The g[illegible] of correlations as different

members of higher taxa are compared. This is a real observation the Gablers cannot handle, except to deny its existence with terms like "unpredictably," "guess work" and "verges on absolute zero." This is hardly a reasoned scientific approach.

There are two methods for comparing the DNA of two species. The first measures the percent of matching sequences in the two DNAs. The second compares a protein coded by each DNA. In both cases, the degree of similarity is found to match the structural similarity and taxonomic classification of the two species.

For example, when alpha hemoglobins (a protein) of mammals are compared, one finds those of humans and gorillas differ by only one amino acid but those of humans and cattle differ by 17 amino acids. In this manner a "family tree" for vertebrates has been constructed based on protein structure which exactly matches that derived from taxonomy. Thomas Jukes provides a lucid discussion of this topic in Scientists Confront Creationsm.

Human Evolution According to the Gablers

> COMMENT: The primary educational flaw of this discussion of hominoid fossils is its incomplete perspective due to piecemeal data. _____ should instead summarize for students all of Eugene DuBois and (especially) the Leakeys' discoveries within a coherent synthesis of current scholarly opinion. Specifically:
>
> First, Eugene DuBois also found a human skull in the same strata in which he found his Java man (or Homo erectus). Homo sapiens and Homo erectus were evidently contemporaries rather than phases of evolutionary development.
>
> Second, below the level at which Louis Leakey discovered Zinjanthropus (i.e., Australopithecus robustus), Homo habilis and Homo erectus, Mary Leakey later (1961-62) found at the same site a stone structure clearly built by humans and simple stone tools supposedly dating back 2 million years. Thus Homo sapiens antedated the hominoids found at the higher level.
>
> Third, expert multivariate computer analysis has suggested that the Australopithecines (including Johanson's "Lucy") were probably a form of extinct ape, perhaps similar to a modern orangutan; and that perhaps the Australopithecines' posture was not erect, at least in the human sense. This tends to confirm Richard Leakey's view, based on additional Australopithecine fossil data, that the Australopithecines were short-legged, long-armed knuckle walkers. In short, the preponderance of evidence points to simultaneous separate families of pongids and hominids at least as much as to hominoids grading into Homo sapiens.

Human evolution gives creationists their biggest problem. They wish to defend at all cost the premise that humans had a unique, nonevolutionary origin, even to the point of revising all of science. Their approach to the growing body of evidence for human evolution is to separate all fossil finds into two mutually

exclusive categories: apes and humans. Thus all Ausralopithecines "were short-legged, long-armed knuckle walkers" or apes, and Neanderthals were fully human and responsible for making primitive tools and a stone "structure" 2 million years ago. Thus they ignore the remaining evidence for intermediate forms combining erect posture, human-like teeth, smaller brains and tool-making behavior.

Concerning their four points:

(1) Contemporaneous existence of populations of Homo erectus and Homo sapiens is not a problem for evolutionary theory and is actually to be expected. This error of the Gablers, that evolution proceeds in a straight line, results from their erroneous definition of evolution.

(2) The tools the Gablers referr to are evidently the crude "cores" and struck flakes from East African deposits between 2 million and 2.5 million years old. They are attributed to Homo habilis not Homo sapiens as the Gablers assert. Their premise of separate creation requires evidence of humans throughout the fossil record.

(3) We are unable to judge the validity of their "expert multivariate computer analysis" suggesting Lucy was a form of extinct ape since no literature citation is given.

An excellent discussion of human evolution may be found in the catalog of the "Ancestors" exhibit at The American Museum of Natural History, Central Park West at 79th Street, New York, N.Y. 10024.

Miscellaneous Gabler Comments

> COMMENT: For taxonomic convenience man may be ranked with primates and mammals. But classifying man as an animal connotes a value judgment peculiar to evolutionists and inappropriate to a general textbook.

We find their objections ludicrous and without merit. It is a further example of an effort to establish their premise that humans were created separately from all other life. All reputable taxonomists so classify humans because they possess all the necessary criteria.

> COMMENT: The high pressures under which oil and gas are found, the polystrate (tree trunk) fossils sometimes protruding through coal beds, the production of manmade coal and oil in only a few hours, suggest caution in conclusively attributing the formation of fossil fuels to long processes over distant aeons.

The only reason the Gablers urge caution in this area is because fossil fuels are an embarrssment to the creationist view that the earth was recently formed. Vertical plant stems probably reflect rapid deposition of material--a local event--but our ability to form petroleum in a laboratory does not mean the same process takes "only a few hours" when carried out in nature.

Bibliography

Eldredge, Niles, The Monkey Business: A Scientist Looks at Creationism. New York: Washington Square Press of Pocket Books, 1982.

A brief, highly readable refutation of creationism presented against a background of evolution and its mechanisms. Written by a noted paleontologist who is curator in the Department of Invertebrates at the American Museum of Natural History.

Frye, Roland Mushat, ed. Is God A Creationist: The Religious Case Against Creation-Science. New York: Charles Scribner's Sons, 1983.

Arguments for including evolutionary theory within the concept of a creator God are presented by theologians and religious scientists. Several essays present well-developed criticisms of biblical inerrancy and its offspring, creationism. A thoughtful collection.

Futuyma, Douglas. Science On Trial: The Case For Evolution. New York: Pantheon Books, 1983.

In the words of Professor Ernst Mayr, Futuyma "...has presented a masterly summation of the evidence for evolution, a point-by-point refutation of the claims of creationists, and finally, a thoughtful discussion of the social role of evolution."

Godfrey, Laurie, ed. Scientists Confront Creationism. New York: W.W. Norton and Co., 1983.

Fifteen scientists, all of whom have confronted creationists in the public forum, soundly rebut creationist arguments in their own fields ranging across the entire scientific spectrum. The essays are informative and written for a lay audience.

Hanson, Robert E., ed. Science and Creation: Reconciling Geology, Theology Biology and Education. New York: Macmillan, 1985.

These essays on science and creationism are the product of a symposium convened by the American Association for the Advancement of Science at its 1981 annual meeting. The collection includes commentary by college-level instructors who have wrestled with the issues in their courses.

McGowan, Chris. In the Beginning: A Scientist Shows Why Creationists are Wrong. Buffalo, NY: Prometheus Books, 1984.

Another excellent presentation of evolutionary theory coupled with a spirited discussion showing why creationism fails as science and why it should be excluded from science classes.

* Moore, John A. Science As A Way of Knowing: Evolutionary Biology. American Society of Zoologists, Thousand Oaks, CA: 1983.

This monograph is intended for people who teach biology and who wish to improve their presentation of evolutionary theory. We quoted extensively from it in chapter 1.

* National Academy of Science. Science and Creationism: A View from the National Academy of Science. Washington: National Academy Press, 1984

This 28-page monograph with four-color illustrations discusses five issues considered to be central to school science curricula: nature of science, the origin of the universe, biological evolution, human evolution, and origin of life. A copy was sent to every public school system in 1984.

Nelkin, Dorothy. The Creation Controversy: Science or Scripture in the Schools. New York: W.W. Norton and Co., 1982.

Nelkin is a sociologist who writes about the creationism controversy in a balanced, dispassionate manner with full attention to its historical development. She uses the textbook dispute to explore the relationship between science and the public.

Newell, Norman D. Creationism and Evolution: Myth Or Rality. New York: Columbia University Press, 1982.

This book provides a fascinating introduction to historical geology. It is written for a lay audience by curator emeritus of the American Museum of Natural History who knows his audience and deeply loves his subject. Creationist arguments are refuted but only incidently to relating the history of earth-life.

Miller, Jonathan and Borin Van Loon. Darwin For Beginners. New York: Pantheon Books, 1982.

This paperback is unique. It combines accurate science and history with a humerous, even irreverent, presentation in comic book style. For those who read it, Darwin will never again be the awesome, remote giant presented in many biology textbooks.

* These publications may be ordered directly, as follows:

Science as a Way Of Knowing: Evolutionary Biology. American Society of Zoologists, Box 2739, California Lutheran College, Thousand Oaks, CA 91360, $3.00, prepaid.

Science And Creationism: A View From the National Academy of Science. National Academy Press, 2101 Constitution Avenue, N.W., Washington, D.C. 20418, $4.00, prepaid.

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